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ABSTRACT

In an effort to provide Indoor Air Quality (IAQ) management guidance, Anne Arundel County Public Schools was selected by the Maryland State Department of Education to develop a program that could be used by other school systems. A major goal was to produce a handbook that was "user friendly." Hence, its contents are a mix of history, philosophy, source reference, and "cook book" on how pollutants or thermal comfort affect the IAQ of schools. The guide is divided into nine sections dealing with the following topics: (1) communications and public relations; (2) historic review; (3) classifying indoor air quality problems; (4) planning and design; (5) leased buildings; (6) training, education, and information; (7) investigation of an indoor air quality problem; (8) building inspections; and (9) building maintenance and operation. Descriptions of 11 indoor air quality problems are appended: asbestos, tobacco products, radon, formaldehyde, volatile organic compounds (carbon monoxide and carbon dioxide), bio-aerosols, blood and body fluid spills, paint, design standards, and roofing. An information supplement is also appended. (SI)

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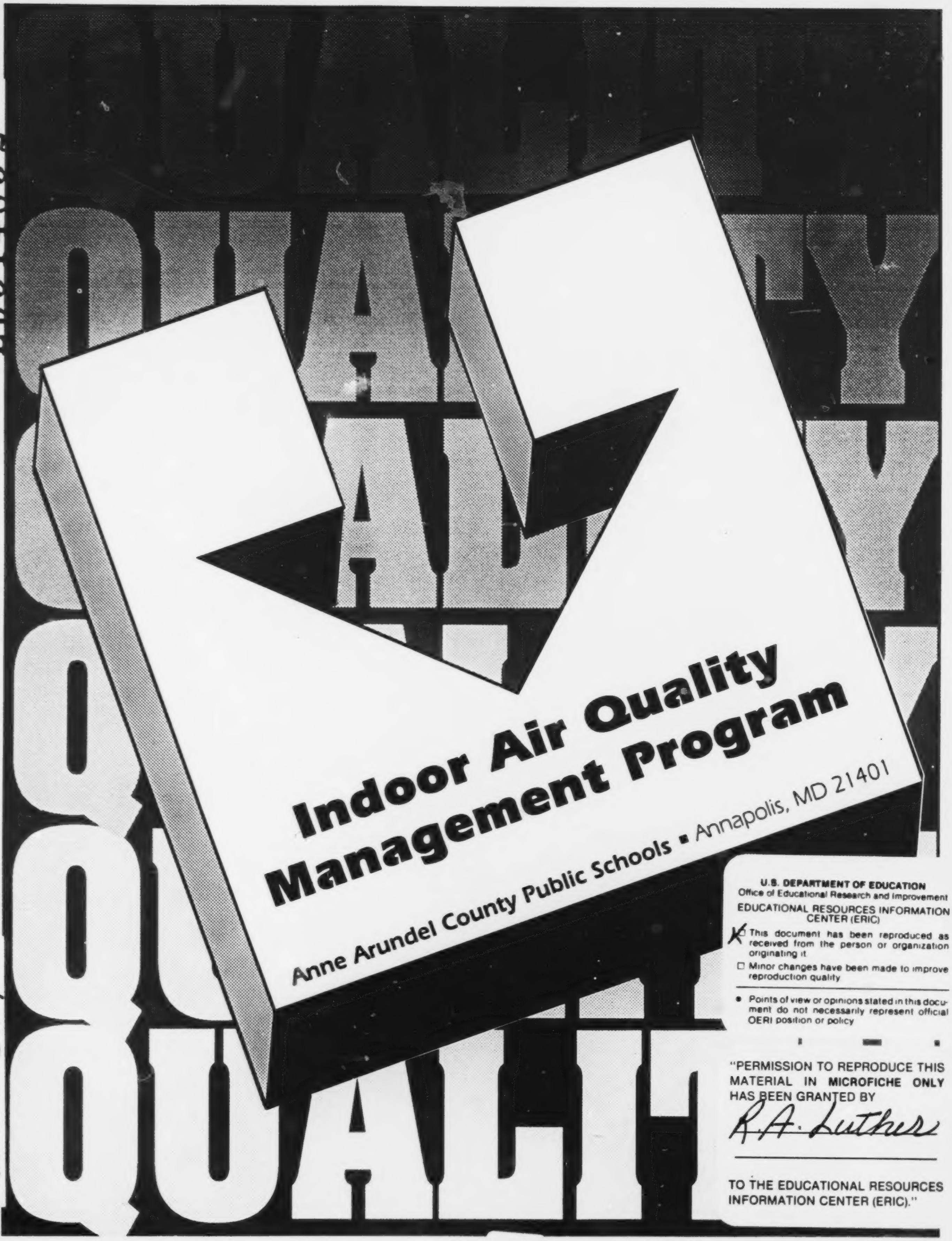

Indoor Air Quality Management Program

Anne Arundel County Public Schools ▪ Annapolis, MD 21401

EA 021 549

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This manual was a team effort of representatives from state and county government agencies, the private sector, and the county public schools. Members of the committee were listed: Mr. Ronald Beckett, Assistant Superintendent for Support Services, Chairman (AACPS); Mr. Ralph A. Luther, Director of Operations and Maintenance, Secretary and Project Manager (AACPS); Mr. Allen Abend, Chief, Office of School Facilities, Maryland State Department of Education; Mr. Joseph Abey, Chief of Air Quality Control, Anne Arundel County Health Department; Mr. Ed Almes, Supervisor of Maintenance (AACPS); Mr. Walter George, Assistant Supervisor of Operations (AACPS); Mr. Mike Cecil, Manager, Industrial Hygiene Services, Occupational Medical Center (OMC); Mrs. Betsy Fleming, Coordinator of Health Issues (AACPS); Dr. Shirley Hansen, President, Hansen Associates; Mr. Dan LaHart, Senior Industrial Hygienist, Maryland Department of Environment; Mr. Ron LeClair, Public Sector Consultant, Maryland Occupational Safety and Health; Mr. C. Thomas Leary, Environmental Program Manager (AACPS); Mr. Michael Raible, Director, Planning and Construction (AACPS) and Mr. Don Rodkey, Principal, Bates Junior High School (AACPS).

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While the intent of this effort was to provide administrators a comprehensive Indoor Air Quality manual allowing the management of school environment, this is still an emerging area of importance. Much is still not known or understood about the school environment and its controlling factors. Accordingly, the user must use judgement in the application of the contents of this document. Aspects of this edition will undoubtly change in the near future. When they do this manual will be updated if and when we know of the change. Users are asked to bring to the attention of Mr. Tom Leary, telephone (301) 255-2535, any error, procedural or otherwise, found in this publication.

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DISCLAIMER

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PURSUANT TO A GRANT FROM THE MARYLAND STATE DEPARTMENT OF EDUCATION.

INTRODUCTION

Concerns over Indoor Air Quality (IAQ) have propelled it into the forefront of workplace problems of the late 80s and it appears destined to be a dominant problem confronting facility managers in the 90s. As the public has become more aware of the health and comfort implications of IAQ, pressure has increased on schools as well as other public and commercial facilities to maintain acceptable indoor air quality.

Beyond these pressures is the obligation to protect the children and other occupants of our schools. IAQ problems not only have a potential for varying impacts on health, they assuredly affect the learning process which is after all "our reason for being." Added to these extremely important reasons to manage our schools' IAQ is the investment the taxpayer has in the school physical plant. A school with IAQ concerns is a building whose design, maintenance or repair is lacking in some aspect.

In an effort to provide IAQ management guidance, Anne Arundel County Public Schools (AACPS) was selected by the Maryland State Department of Education to develop an Indoor Air Quality Management Program that could be used as a model for other school systems. A major goal was to produce a handbook that was "user friendly." This document is the product of that effort. Thus, you will find its contents to be a mixture of history, philosophy, source reference and "cook book" on how pollutants or thermal comfort parameters (e.g., temperature) affect the IAQ of schools. Users who find sections that can/should be improved upon are asked to use the tear sheet at the end of Volume I to provide their comments.

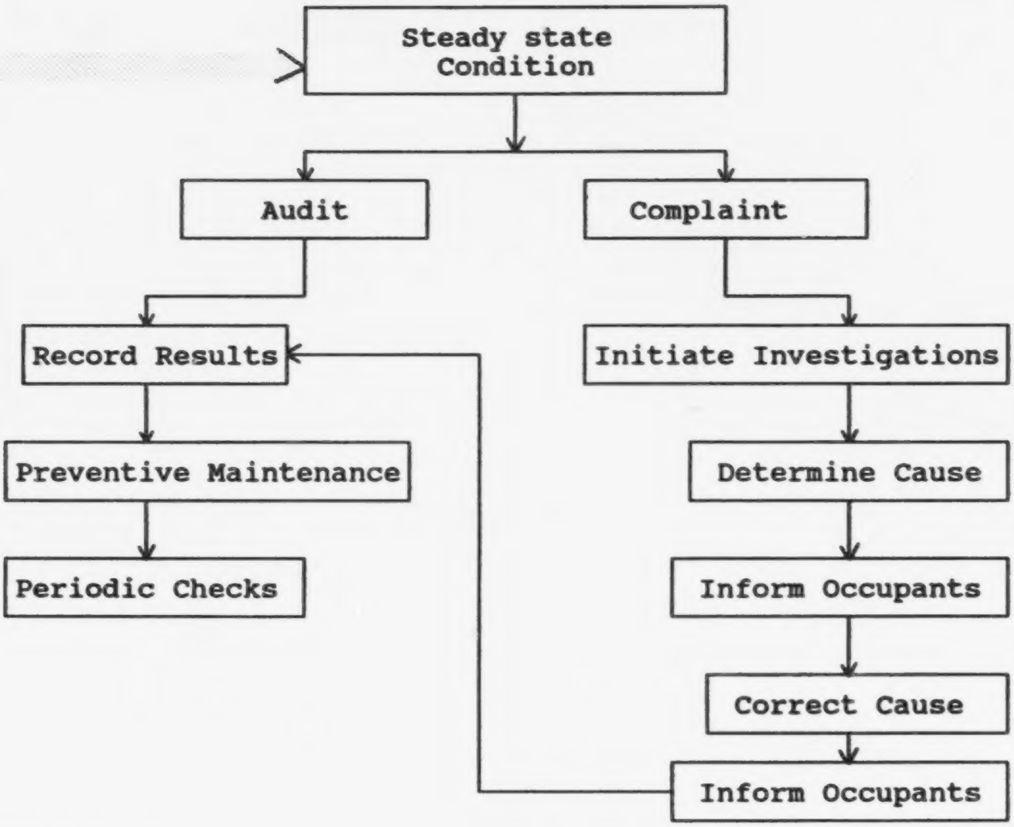
Volume I presents an overview of school IAQ, its history, causes and effects (as we know them today) on our student and employee populations, the importance of open communications, responsive and thorough IAQ investigations, the operation and maintenance (O&M) aspects of IAQ, and several appendices that address specific potential IAQ pollutants in a "how to" format. Selected Bibliographies can be found in Volume II if further research is desired.

Volume II contains backup reference information in the form of pertinent protocols, laws, manuals, regulations, articles, etc. These are provided only as additional source information. They complement Volume I only. In no way is the first volume dependent for use or understanding on any item in the second volume.

While this manual attempts to document the full spectrum of school IAQ issues, it is intended as a guide only. Each situation is unique. For example, while no one truly knows the number of chemically sensitive people there are in this country, this group does exist. An IAQ problem in a facility housing one or more chemically sensitive individuals will offer different challenges than a situation with no such person. Other than to urge school identification of these people, we do not address their possible unique needs specifically in this document. What we do urge of all users is that they tailor the following information to accommodate their specific needs on a case by case basis. A common thread that binds all IAQ problems is the need to be pro-active in its management. The damage and disruption an IAQ episode brings to the educational process far outweighs the costs of maintaining an aggressive and well thought-out management program.

The implementation of IAQ management within our schools will not just happen. It requires leadership. The Maintenance Division has that responsibility. The following overly simplistic chart depicts the flow of the IAQ management process as described in this document.

Figure 1. Flow of IAQ Management


Steady state Condition
Audit
Complaint
Record Results
Initiate Investigations
Preventive Maintenance
Determine Cause
Periodic Checks
Inform Occupants
Correct Cause
Inform Occupants

COMMUNICATIONS AND PUBLIC RELATIONS

Like many other school issues, IAQ problems can result in tension between those affected and those responsible. Successfully resolving an IAQ problem hinges as much on people's understanding that something is being done to resolve the problem as it does on the actual expenditure of resources leading to the "fix." To instill "customer confidence," open communications is vital. Efforts to downplay the problem, or its visibility, almost always result in the reverse effect. An open sharing of information from the beginning is necessary to ensure the credibility of the process. In the long run, this openness will save time and effort, and keep the focus on the actual problem solving.

Another factor in forming a positive relationship with the affected community is the response time. A rapid response to calls for assistance begins to build the foundation for such a positive relationship. An organized approach during the investigation phase is equally important. For this reason, we have developed the investigation methodology offered in this document. Sharing copies of completed reports and answering questions while on site further develops trust and confidence. In combination, all these traits reflect the professional approach necessary to earn the confidence and respect of all concerned.

Communications is not a one-way affair. Communication should foster a mutual understanding of facts, issues and concerns between the investigator, the administrator, the school staff, the parents and the students. One area in which communication and understanding is of particular concern is the existence of individuals who may be especially sensitive to indoor pollutant including chemical sensitivities. Management of the IAQ problem for these individuals may require targeted actions to insure their health and well being. The following guidelines apply:

1. A list of all asthmatic, allergic or chemically sensitive students/staff will be maintained in each school. All entries will have a doctor's certificate attesting to this condition.

2. The Coordinator of Health Issues will review the lists on or before November of each school year and make specific recommendations as may be required.

3. The principal(s) will meet with the Coordinator of Health Issues, school staff, and parents, and will establish a plan of action.

    a. The Coordinator of Health Issues will assist school(s) in management of decisions and the processes that will be followed.
    c. The County Health Department staff will assist, as appropriate, AACPS in this program.

Finally, it is important that, a single voice speak during the investigation process.

HISTORIC REVIEW[1]

IAQ problems are a relatively new phenomenon originating from a number of factors. Often more than one factor may be a contributor to an IAQ problem. Moreover, a specific problem may be brought about by factors not mentioned here. An open mind in investigating such problems is important.

ENERGY CONSERVATION

The energy crisis of the early 1970s caused building owners to expend considerable effort toward energy conservation. Buildings were planned and renovated to reduce outside air infiltration. Window and door openings were reduced and more tightly sealed. Outside air quantities for mechanical systems were minimized. In some cases, the operating times for heating, ventilation, and air conditioning equipment were decreased. Standards were reduced for the number of air changes in a room. Buildings became more compact in an effort to minimize perimeter wall surface, thereby reducing heat loss or heat gain. Modern buildings have more interior space that does not access to exterior walls. As a result, modern facilities are more apt to retain potentially hazardous contaminants such as particles and gases for longer periods of time and in higher concentrations than ever before.

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[1] The material on the succeeding Pages is almost wholly extracted from "Indoor Air Quality: Maryland Public Schools," Maryland State Department of Education, 1987. Portions/passages have been modified to conform with the intent of this document.

The thermal environment also may have been adversely affected by these energy conservation measures. For example, to reduce the need to reheat conditioned air, the temperature of the cooling medium frequently was raised. This resulted in increased humidity, reduced human comfort, and an enhanced environment for the growth of bacteria, fungi and other biological contaminants.

It is important to emphasize that an energy efficient building need not be the antithesis of a building with good indoor air quality. Later in this manual, ways to preserve energy efficiency while achieving good indoor air quality are discussed.

PRODUCT TECHNOLOGY

The number and type of contaminants introduced into indoor air by new products have grown rapidly in the last few decades. Each year, new products are introduced for use during and after the construction of buildings. The effects of these products and materials on humans often cannot be predicted. Many years may pass before the dangers of a chemical are realized and brought into public awareness. Consider, for example, the past and present uses of formaldehyde, asbestos, tobacco and solvents released by glues. Product technology has given us materials that directly affect the quality of indoor air in ways that are of increasing concern to building planners and users.

MAINTENANCE

In budget decisions, teachers' salaries, instructional materials, and building construction are frequently given higher priority than the maintenance of school facilities. As a result, basic maintenance activities such as changing air filters and cleaning or replacing mechanical equipment have not occurred as often as they should. The re-evaluation of maintenance practices will assuredly come about as we begin to understand their relationship to indoor air quality. Maintenance functions must receive sufficient funding if we are to ensure the health of students and staff.

EDUCATION AND TRAINING

People who plan, design, maintain, and operate buildings have not received formal education or inservice training regarding indoor air quality. Practicing architects, engineers, educational facility planners, and maintenance/operations personnel may not have received training in the link between their decisions and the quality of indoor air. Because IAQ is a relatively new phenomena, these and other health-related subjects are frequently absent from the curricula in architectural and engineering schools. Indoor air quality is discussed in terms of thermal comfort but not as an environmental health factor. Workshops are now emerging that are specifically geared to those people involved in the planning and operation of school facilities; however, they do not begin to meet the need. More inservice training programs and professional continuing education courses will have to be provided to fill this educational gap.

CHANGE IN BUILDING USE

Changes in programs during the life of a building are common in the educational field. These changes can be initiated by federal laws, such as P.L. 94-142 (Education for All Handicapped Children Act of 1975) or by unique state and local program implementation. Facility planners or the operations and maintenance staff may have to modify school buildings to accommodate the new use. Building changes often take the form of spatial modifications, the addition of new equipment, or alterations to the electrical and lighting systems. Many times, the mechanical or distribution systems receive little or no corresponding change, which results in poor quality of indoor air due to over (or under) heating, cooling, and/or ventilation.

COST OF CONSTRUCTION

Construction costs have escalated in recent decades. To reduce costs, building technology has been used to decrease the volume of a building, reduce the number of windows, create multi-use educational spaces, and/or simplify mechanical system designs. Cost decisions can and do have a negative impact on the quality of indoor air by creating buildings with few or no operable windows and mechanical systems that offer minimal ventilation under optimum conditions. Increasingly, planners will need to include indoor air quality concerns in construction cost decisions.

CLASSIFYING INDOOR AIR QUALITY PROBLEMS

Indoor air problems can be discussed under two categories:

(1) Thermal environment involves several variables that cause relative degrees of human comfort or discomfort. These include air temperature, radiant heat, humidity, and air movement. Adverse thermal conditions can create discomfort for students and staff and, in turn, affect the quality of the learning situation and the productivity of the staff.

(2) Air contaminants consist of numerous particulates, fibers, mists, fumes, bioaerosols, gases, and vapors. These contaminants can impair human performance as well as present a full range of potential problems from mild irritation of the upper respiratory system to a serious health threat. Some contaminants, such as formaldehyde, are sensitizing agents. If an individual becomes sensitized, subsequent exposures at even low levels can generate adverse health effects. Synergism may exist synergism between contaminants and the thermal environment. For example, the rate of formaldehyde emissions from building materials is higher under higher temperatures and humidity. Synergistic effects may also result from multiple contaminant exposures. Thus, the total cancer risk from the combined exposure to tobacco smoke and radon appears to be greater than the sum of the risks from exposure to each contaminant alone. Additive or synergistic health effect thresholds, is though to be one cause of sick building syndrome.

THERMAL ENVIRONMENT CONDITIONS

Satisfaction with the thermal environment is based on a complex, subjective response to several interacting variables. The design and construction of the facility and all its subsystems, as well as the use of an occupied space and the operation of its heating and air conditioning systems, will determine the degree of satisfaction with the thermal environment.

Not all individuals react the same to a given thermal environment. The degree of comfort relates to an individual's physical activity, body heat exchange with the surroundings, and physiological characteristics. The heat exchange between the individual and surroundings is influenced by:

- air temperature
- amount of clothing
- relative humidity
- air movement
- thermal radiation
- activity level
- direct contact with surfaces not at body temperature.

While ideal thermal conditions are difficult to define for any one individual in a particular setting, the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) has produced a consensus standard (Thermal Environmental Conditions for Human Occupancy, ASHRAE 55-1981). This standard is based upon experience and research that specifies conditions likely to be thermally acceptable to at least 80 percent of the adult occupants of a space. These conditions, as they most commonly apply to educational facilities, are presented under the Temperature, Humidity and Ventilation section and Appendix J, Design Standards, of this document. A more complete explanation of the conditions, factors affecting comfort, and methods for their determination and measurement can be found in the ASHRAE Standard. Table J-1, page 123, is from ASHRAE Standard 55-1981 summarizes these comfort levels.

Studies comparing the basal metabolic (at rest) rate of children (kindergarten through high school) with that of adults in the same environment have found the comfort levels for pupils and teachers separated by at least 5°F. Children are generally more comfortable in somewhat cooler temperatures due to their higher metabolic rate.

INDOOR AIR CONTAMINANTS

Indoor air contaminants can be divided into particles (solids or liquid droplets) and gases (vapors). Within these two types are compounds known to be irritants that may cause harm to a person's health. Contaminants which are irritants may impair human performance without being highly injurious to an individual's health.

The standards for vapors and gases specify a quantity of pollutant per unit volume; e.g., parts per million of air (ppm). Standards for particles often specify the mass concentration of particles expressed as micrograms per cubic meter of air (ug/m^3). These include all particle sizes, or total suspended particulate (TSP) concentration. Large particles are filtered by the nasal passages and cause no adverse physiological response unless they are allergenic or pathogenic. Smaller respirable suspended particles (RSP) are important because they can lodge in the lungs. The size of RSP's ranges up to 10.0 micrometers (um).

Particles of specific interest include:

1. Respirable[2] particulates as a group;
2. Tobacco smoke - solid and liquid droplets - (tobacco smoke also contains many vapors and gases);
3. Asbestos fibers;
4. Allergens (pollen, fungi, mold spores, insect parts and feces); and
5. Pathogens (bacteria and viruses), almost always contained in or on other particulate matter.

Vapors and gases of particular interest include:

1. Carbon monoxide (CO);
2. Carbon dioxide (CO_2) as an indicator of inadequate ventilation;
3. Radon;
4. Formaldehyde (HCHO);
5. Other volatile organic compounds (VOC); and
6. Oxides of nitrogen (NO and NO_2).

(See Table 1 on page 8, Description of Contaminants.)

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[2] Particulates that are 10 microns or less in size and therefore remain suspended in the air for extended periods and are easily inhaled.

Most indoor pollutants emanate from inside sources even if they also exist outdoors. For example, nitrogen oxides and carbon monoxide, found in the air outdoors, also have indoor sources. People are sources of CO_2 and biomatter[3] as well as other contaminants characterized as "body odors." Activities such as smoking, cleaning, gluing, woodworking, science laboratory projects, and cooking also cause pollution. Building materials and finishes can also give off pollutants.

Furnishings, business machines, and appliances - particularly unvented or improperly vented heaters and ranges - can be contaminant sources. Radon and insecticides may enter the indoors through cracks, drains, or by diffusion from the surrounding soil. Heating/ventilation/air-conditioning (HVAC) systems, drains, plumbing systems, and poor construction or maintenance practices can result in "environmental niches" where pathogenic or allergenic organisms can collect and multiply to be re-introduced into the air.

The nonuniform mixing of the indoor air often presents additional problems in buildings. Where HVAC systems are out of balance or improperly designed, parts of the facility will be poorly ventilated. Pollutant concentrations vary spatially as well as temporally. Pollutants can emanate from point sources, such as an unvented space heater, or from area sources, such as wall panels. These variations add further nonuniformity to the pollutant concentration.

Table 1 presents a summary of contaminants covered in this manual. This information is contained also in the different **Appendices**. The Table provides a better means of cross-comparison and reference.

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[3] Organic matter such as hair, dandruff, skin, parts of insects, etc.

Description of Contaminants (Table 1)

	DESCRIPTION	**SOURCES**	**STANDARDS & GUIDELINES**
ASBESTOS	Asbestos is composed of small natural mineral silicate fibers.	Widely used in insulation and other building materials until recently. The use of asbestos-containing spray-on materials is banned in U.S. buildings today.	A safe level of asbestos fibers has not been established. A standard for the assessment of asbestos material and selection of an appropriate action will be detailed in the final federal regulations (due October, 1987) under the Asbestos Hazard Emergency Response Act of 1986 (AHERA). AHERA also will provide a clearance level for abatement projects now proposed at no higher than .005 f/cm^3 of air using transmission electron microscopy (TEM).
TOBACCO SMOKE	Tobacco smoke consists of solid particles, liquid droplets, vapors and gases resulting from tobacco combustion. Particles of condensed combustion products are almost in the respirable range and over 4,000 specific materials have been identified in the particulates and associated gases.	Tobacco Combustion	No general levels have been agreed upon. ASHRAE Standard 62-1981 specified dilution with smoke-free air in quantities of 14-25 cubic feet per minute (cfm) per person where smoking is permitted, depending upon the type of space. The ASHRAE standard is currently being revised but no significant change in these levels is now contemplated.
RADON	Radon is a radioactive gas, the first decay product of Radium-226. It decays into solid alpha emitters which can be both inhaled directly or attach to dust particles which are inhaled. The unit of measure for radon is picocuries per liter (pCi/1).	Radium is ubiquitous in the earth's crust in widely varying concentrations. Well water can also have high concentrations of radon. Masonry building blocks can have radium concentrations. The earth around buildings however is the principal source of indoor radon. Radon penetrates cracks and drain openings in foundations, into basements and crawl spaces. Water containing radon will outgas into spaces when drawn for use indoors. Some building materials will outgas radon, some of which may enter buildings.	Organization and Radon level above which mitigating action is indicated (picocuries per liter). U.S. Mine Safety and Health Administration 16 National Council for Radiation Protection and Measurements 8 World Health Organization 5.4 U.S. Bonneville Power Administration 5 EPA 4 ASHRAE Standard 62-1981 2
FORMALDEHYDE	Formaldehyde is a colorless water-soluble gas. Due to its wide use, it is frequently considered separately from other volatile organic compounds (VOCs).	Materials containing formaldehyde are widely used in buildings, furnishings, and consumer products. Urea-formaldehyde resins are used in the manufacture of plywoods, particleboards, and textiles. The walls of some buildings have been insulated with urea-formaldehyde foam insulation (UFFI). Formaldehyde outgases from the above mentioned products. Tobacco smoke and other combustion products are secondary sources. Indications are that in time outgassing diminishes from materials.	Scandinavian countries have 0.1 ppm standard. ASHRAE has included o.1 ppm in its Standard 62-1981, but the formaldehyde provision has yet to be made mandatory in building codes. Some states in the U.S. have established 0.4 ppm in their codes for residences. The Department of Housing and Urban Development has developed a product standard for emission rates of plywood and other wood materials for manufactured housing.

Description of Contaminants (Table 1)

	COMFORT & HEALTH EFFECTS	MEASUREMENT METHODS	CONTROL MEASURES
ASBESTOS	No acute health or comfort effects due to asbestos are known. Fibers deposited in the lung are the only known cause of mesotheliomas, a fatal cancer of the pleual or peritoneal linings of the body. Asbestosis and other lung conditions also have been associated with asbestos exposures.	Phase contrast microscopy is used as a screening method for sampling asbestos fibers in the air. Fibers other than asbestos are also counted. Electron microscopy is a method which can distinguish asbestos definitively, but it is much more expensive than PCM and takes longer to complete. The proposed AHERA regulations require schools to use the TEM protocol for clearance samples for projects. Its use is phased-in through Oct 7, 1990.	Asbestos abatement in the U.S. is being handled as a special case separately from other air pollutants by U.S. agencies due to the perceived high public risk. the methods of abatement include repair, removal, enclosure and encapsulation.
TOBACCO SMOKE	The effects of tobacco smoke on smokers are well known. However, many people who do not smoke object to smoke in their environments because of eye, nose and throat irritation. The health effect on non smokers has received increased attention. Acute health effects have been found in the lung function of children and spouse of smokers, allergic reactions occur in a small fraction of the population.	Particulate concentration is measured by optical scattering or gravimetrically by particles collected on filters. Gas chromatographs are used to study gaseous components. Enough work has been done so that reasonable estimates of the source strength can be made by simply counting smokers and estimating the about 30% of adults smoke and consume about two cigarettes per hour.	Prohibition of smoking in public spaces is becoming more common. Isolation of smokers is partially effective, but careful management of ventilation is required. If well applied and properly maintained, high efficiency air cleaners and gas filters are effective. Since very large ventilation rates are necessary to dilute smoke levels enough to be unobjectionable to most nonsmokers, dilution is often not totally effective.
RADON	No sensory perception or acute health effects are known. The chronic effect is lung cancer or other lung dysfunction due to the retention of radon decay products in the lung. These chronic effects are among the best known of all indoor pollutants, as the result of studies on uranium miners. It is speculated that non-occupational radon exposure in the U.S. may cause between 2,000 and 20,000 additional cancer deaths per year.	Inexpensive charcoal canisters (less than $15) are available to screen radon concentrations over a four to seven day period. Relatively inexpensive alpha track detectors (less than $50) are available for survey use which integrate radon concentration over a one month to one year period. Air sampling instruments for real-time measurements are more expensive. No inexpensive method exists to measure radon decay products concentrations.	Sealing of foundations to prevent entry has been demonstrated to be effective, although the long term reliability of sealing is unknown. Specific ventilation of basement areas and crawl spaces has also been shown to be effective. Increased ventilation with outdoor air will lower radon levels for a given building. However, radon levels do not correlate well with ventilation rates among different buildings; i.e., buildings with low ventilation rates will not necessarily have high indoor radon levels and vice versa.
FORMALDEHYDE	Formaldehyde has a pungent odor and is detected by many people at levels of about 0.1 ppm. Besides the annoyance, it also causes acute eye burning and irritates mucous membranes and the respiratory tract. Formaldehyde has also caused nasal cancer in laboratory animals, but chronic effects have not been established for human beings. Some people exhibit a high sensitivity to very small concentrations.	Inexpensive passive samplers and detector tubes have been developed. The more accurate method of collecting formaldehyde is by impingers. Concentrations are then determined by colorimetric methods.	For problem UFFI cases, removal is indicated although the cost can be high. Even then, residual materials may remain in the structure and continue to outgas. Increased temperature, humidity, and ventilation will accelerate outgassing. Therefore ventilation may not be an effective means for mitigation. Some manufacturers are producing products with lower outgassing rates. Some surface treatments are being used to seal against outgassing, but long-term effectiveness is still being studied.

Description of Contaminants (Table 1)

	DESCRIPTION	SOURCES	STANDARDS & GUIDELINES
OTHER VOLATILE ORGANIC COMPOUNDS (VOCs)	There are hundreds of other volatile organic compounds that are found in the indoor air, sometimes in concentrations which are suspected of being harmful. Those listed below do not comprise a complete list. acetone - by-products of human metabolism, cleaners, personal care products, tobacco smoke acrolein - tobacco smoke alcohols - by-products of human metabolism, cleaners, personal care products, tobacco smoke ammonia - cleaners, tobacco smoke aromatic hydrocarbons -combustion processes, pesticides, paints, solvents, tobacco smoke benzene - combustion processes, gasoline, solvents, tobacco smoke chlorinated hydrocarbons - PCBs, wood preservatives, solvents organophosphates - pesticides phenols - equipment, furnishings, tobacco smoke toluene - adhesives, gasoline, paints, solvents, tobacco smoke.		No standards have been set for VOCs in non-industrial settings. NIOSH has recommended occupational standards for many compounds. ASHRAE Standard 62-1981R (as currently proposed) includes a rationale suggestion that in the absence of better data, the NIOSH limits be divided by 10, to account for the possible continuous, rather than workplace time of exposure and to account for the elderly, young and infirm in the general population.
NITROGEN OXIDES	The two most prevalent oxides of nitrogen are nitrogen dioxide (NO_2) and nitric oxide (NO). Both are toxic gases with NO_2 being a highly reactive oxidant, and corrosive. NO gradually reacts with the oxygen in the air to form NO_2.	The primary sources indoors are combustion processes, such as unvented combustion appliances, vented appliances with defective installations, welding, and tobacco smoke.	No standards have been agreed upon for nitrogen oxides in indoor air. The U.S.National Ambient Air Quality Standards lists 100 ug/m^3 as the long term (8 hour) limit as does ASHRAE.
CARBON MONOXIDE	CO is a colorless, odorless, and tasteless gas. It results from incomplete oxidation of carbon in combustion.	Incomplete oxidation during combustion in gas ranges, unvented heaters, leaky wood and coal stoves, and tobacco smoke may cause high concentrations of CO in indoor air. Worn or poorly adjusted and maintained combustion devices can be significant sources. Automobile, bus, or truck exhaust entering buildings from attached garages, nearby roadways or parking areas can also be a source of CO.	No standards for CO have been agreed upon for indoor air. The U.S. National Ambient Air Quality Standards is 40 mg/m^3 for one-hour.
CARBON DIOXIDE	CO_2 is an odorless, tasteless, and colorless product of completed carbon combustion.	All combustion processes and the human metabolic processes are CO_2 sources. Concentrations of CO_2 from people and smoking are always present in all occupied buildings.	U.S. submarines operate at 7,000 ppm or less. The present ASHRAE Standard 62-1981 sets 2,500 ppm as the upper limit but is proposed at 1,000 ppm. The outdoor level is usually 300 ppm. Indoor concentrations are usually in the range of 5000 to 1,000 ppm.
BIO AEROSOLS	Biological material, bacteria, viruses, fungi, mold spores, pollens, and inset parts are ubiquitous in indoor environments. These particulates range from less than one to several microns in size. When airborne, they are usually attached to dust particulates of various sizes so that all sizes of airborne particulates may include them.	People and animals "shed" such materials. Drapery, bedding, carpeting, and other places where dust collects can harbor them. Cooling towers have been known to be incubators of Legionella bacteria. Dirty air-conditioning equipment, humidifiers, condensate drains, and ductwork can incubate bacteria and molds. High humidity areas exacerbate their growth.	No standards exist for general indoor air applications except that ASHRAE recommends a relative humidity between 30 and 60%.
BODY FLUIDS	Blood and body fluid spills such as vomit, urine, saliva, etc.	Usually children but may be any building occupant resulting from an illness or personal injury or chronic condition.	No standards have been set beyond good hygiene practices. Use of school based body fluid and first aid kits should be standard procedure. Follow the hand washing techniques in Appendix H.

Description of Contaminants (Table 1)

	COMFORT & HEALTH EFFECTS	MEASUREMENT METHODS	CONTROL MEASURES
OTHER VOLATILE ORGANIC COMPOUNDS (VOCs)	Several of these compounds have been identified individually as causing acute and chronic effects at high concentrations. Some have been directly linked to cancer in humans and others are suspected of causing cancer. The effects of combinations of the compounds at low concentrations have been suggested as causes of several "sick building" situations.	Gas chromatographs and portable photoionization meters are used for laboratory and field studies to measure VOC concentrations. No inexpensive monitors are suitable for extensive field use currently exist.	Where practical, uses of these sources should be restricted, and these materials should be stored in well ventilated areas apart from occupied zones.
NITROGEN OXIDES	Oxides of nitrogen have no sensory effect in low concentrations. Acute effects of lung dysfunction have been reported at higher concentrations. Oxides of nitrogen produce immediate short-term effects on airway activity. Persons at special risk are those with chronic bronchitis, emphysema, asthma, and children under 2 years old. Chronic effects are not well established.	Small inexpensive passive NO_2 monitors suitable for field use are available. Nondispersive infrared techniques are used to measure nitrogen oxides in laboratory settings or for continuous monitoring.	Venting the NO_2 source to the outdoors is the most practical measure for existing conditions. Manufacturers are developing devices which generate lower NO_2 emissions.
CARBON MONOXIDE	Acute effects are due to the formation of carboxyhemoglobin in the blood, which inhibits oxygen intake. At moderate concentrations, cardiovascular disease, impaired vision, and loss of brain function may result. At higher concentrations CO exposure is fatal.	Some relatively high-cost infrared-radiation absorption and electrochemical instruments do exist. Moderately priced real-time measuring devices are also available. A passive monitor is currently under development.	It is most important to be sure combustion equipment is maintained and properly adjusted. Vehicular use should be carefully managed adjacent to buildings and in vocational programs. Additional ventilation can be used as a temporary measure when high levels of CO are expected for short periods of time.
CARBON DIOXIDE	At concentrations above 10,000 ppm, some loss of mental acuity has been noted.	Instruments exist which are reliable and inexpensive for most commercial applications.	Ventilation methods are used to control carbon dioxide.
BIO AEROSOLS	Tuberculosis, measles, staphylococcus infections and influenza are known to be transmitted by air as is Legionnaires disease. Pollens and molds can cause allergic reactions for a significant portion of the population.	Air samples must be collected on appropriate microbial media and incubated for visual examinations of viable growths. Microscopic examinations of collected dust can be used to identify molds and pollen. No inexpensive field monitors exist which are suitable for large-scale use. Active sampling should be the method of choice (e.g., Anderson two-stage, impactor or impinger).	General good housekeeping and maintenance of heating and air-conditioning equipment are very important. Adequate ventilation and good air distribution also helps. Higher efficiency air filters remove viable particles along with other particulates. Cooling tower treatment procedures exist to reduce levels of Legionella and other organisms.
BODY FLUIDS	Immediate cleanup and disposal of any body spills should be practiced. With proper precautions in any cleanup, there should be no adverse discomfort or health effect on occupants.	None are applicable.	Each school is provided with a body fluid spill and first aid kit. The spill kit should consist of a bucket, disinfectant, "barf-clean," disposable gloves, paper towels, sealable plastic bags, band-aids and gauze (for use by the person doing the cleanup) and a brush. School personnel should insure the kit is maintained with all these components.

EXPOSURE STANDARDS

NO STANDARDS FOR INDOOR AIR CONTAMINANT LEVELS HAVE BEEN ESTABLISHED SPECIFICALLY FOR CHILDREN IN SCHOOLS. However, "human exposure" guidelines for a number of air pollutants have been established. Various governmental agencies and professional organizations have recommended concentration limits. Differences among the guidelines stem from underlying differences in populations the guidelines are designed to protect, the level of protection, and differing assumptions concerning exposure. Guidelines designed to protect the public health are uniformly more stringent than occupational guidelines. This is largely due to the fact that public health guidelines are usually designed to provide protection to the entire public, including the elderly, the young, and some individuals with particular health sensitivities, and exposures are assumed to be involuntary. Occupational limits, on the other hand, are intended to protect a relatively healthy adult workforce, not the more sensitive individuals/ Occupational limits also assume little or no exposure to the contaminant beyond the normal 40-hour week, and exposure is assumed to be voluntary. The following organizations have established concentration limits for air pollutant exposures.

PUBLIC HEALTH STANDARDS AND GUIDELINES

The Environmental Protection Agency (EPA) has developed National Ambient Air Quality Standards (NAAQS) for six outdoor air pollutants. These standards are designed to protect the general public, including susceptible population subgroups. They may be more applicable for evaluating the indoor environment where protection of similar population is desirable. The Division of Stationary Source Enforcement of Maryland's Air Management Administration may be consulted concerning the EPA NAAQS.

The Hazardous Pollutant Evaluation Section of the State of Maryland's Air Management Administration has developed "screening" levels for indoor air pollutants and may be consulted concerning the use and derivation of these levels as well as the status of regulations.

The World Health Organization (WHO), an agency of the United Nations, recently published air quality guidelines for 28 organic and inorganic substances. The guidelines are set to protect the public health, including susceptible population subgroups.

The Canadian Minister of National Health and Welfare published indoor air quality guidelines for nine pollutants or pollutant categories. Their application is intended for residential environments and are designed to protect the general public, including susceptible population subgroups.

The American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE) references the EPA NAAQS plus approximately 30 contamination limits selected from current practices of various states, provinces, and other countries (ASHRAE Standard 62-1981). The standard is currently being revised. Information regarding ASHRAE Standards is available from ASHRAE, 1791 Tullie Circle, N.E., Atlanta, GA 30329.

OCCUPATIONAL STANDARDS AND GUIDELINES

The Occupational Safety and Health Administration (OSHA) regulates workplace exposure through the use of Permissible Exposure Limits (PELs). The National Institute for Occupational Safety and Health (NIOSH) conducts health effects research and studies, and then makes recommendations to OSHA for new legislation or regulations. The OSHA PELs and NIOSH recommendations are contained in Department of Health and Human Services (DHHS) NIOSH Publication No. 85-114, 'Pocket Guide to Chemical Hazards,' available from the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402.

The American Conference of Governmental Industrial Hygienists (ACGIH) annually publishes a list of Threshold Limit Values (TLVs). TLVs are to be used as guidelines for the control of potential health hazards in the workplace. TLV booklets are available from the ACGIH, 6500 Glenway Ave., Building D-7, Cincinnati, OH 45211-4438.

The American Industrial Hygiene Association (AIHA) has developed Workplace Environmental Exposure Limit (WEEL) Guides for a number of chemical substances for which there are no legal or authoritative limits. The WEEL Guides are available from the AIHA, 475 Wolf Ledges Parkway, Akron, OH 44311-1087.

The National Academy of Sciences (NAS) Committee on Toxicology develops recommended exposure limits for narrowly defined occupational groups (military personnel). On at least one occasion, they have recommended an indoor air limit for military housing (the termiticide Chlordane was involved). The NAS Committee on Toxicology may be contacted in Washington, DC, (202) 334-2538.

THE POPULATION AT RISK

When evaluating the potential health effects related to indoor air quality, the following factors must be considered: age, sex, occupation, and health status. The school system population (students and employees) ranges in age from approximately five years to over 60 years, with special education services mandated from birth to age 21. Factors related to the younger age groups (elementary school children) include a higher respiration rate per unit body weight and less ability to comprehend and communicate adverse health responses. This latter concern also may be applicable to a wider age range of special education students.

The health status of the school population is important since many indoor air pollutants may aggravate past or present diseases. For example, individuals with lung disease such as asthma, bronchitis, emphysema, etc. will have their symptoms aggravated by respiratory irritants. People under medication likewise could be similarly affected. There also appears to be individuals in the population who are sensitive to certain chemicals. A definition for this group or a prevalence is not agreed upon or known at this time.

NATURE OF THE EXPOSURE

Exposure to indoor air pollutants (and the ensuing health effects) is generally classified as acute or chronic. **Acute exposure** to a contaminant may be measured in hours, minutes, or in some cases, seconds. **Acute health effects** are those manifested almost immediately like the irritation of mucous membranes or a cough. **Chronic exposure** to a contaminant refers to a repeated exposure over a long duration usually measured in days, months, or years. **Chronic health effects** are those that develop and persist over time such as cancers, liver and kidney disease, etc. Since chronic effects develop over time, their appearance may or may not coincide with exposure to the causative agent(s).

Although some elevated chemical exposures can occur indoors due to spills and the misuse of chemicals, exposures in the indoor environment are generally characterized by the comparatively low concentrations of large numbers of pollutants and the subtle health effects that may result. Typical concentrations of individual pollutants in the indoor environment are 100-1000 times below those sometimes found in the industrial workplace.

The adverse health responses to indoor pollutants (e.g., headache, malaise, etc.) are often subtle, with the reactions not always immediately related to an air contamination problem. Conversely, industrial workplace exposures are more commonly related to clear toxic reactions (e.g., choking, severe irritation, tremors).

Applicability of Workplace Exposure Limits

In the industrial workplace, where exposure is routinely monitored, single or small numbers of contaminants can be identified for worker exposure potential. By the nature of the industry today, alertness to the hazard is common and protection for workers is provided where necessary. Occupational standards promulgated by OSHA, ACGIH, and NIOSH represent conditions under which it is believed most may be repeatedly exposed day after day without adverse health affects. The standards are based on an 8-hour time weighted average exposure and assumes no exposure the rest of the 24-hour period. Also, they are designed for a healthy adult work force.

The school situation is quite different. The types of substances found are many, teaching is the profession, and the occupants' health vary greatly as do their reactions to pollutants. Often the industrial standards will not apply in the school situations. In an effort to begin to address this shortcoming, approximately 50 recommended "guidelines" for non-industrial indoor air pollution sources have been proposed by the World Health Organization, ASHRAE, and the Canadian Government. In spite of this progress, the many potential school pollutants likely will mean no guidelines or standards are to be found. However, for further information on what guidelines are available, the reader is referred to Volume II. **As a minimum, it is a place to start.**

The State of Maryland has informally adopted a "screening" approach to establish guidelines for "air toxic" limits. This process involves workplace standards and safety factors. The safety factors are applied generically; that is, the same safety factor is applied to a large group of chemicals generally, with little or no regard to toxicity or mode of action within the human body. If the air concentration of an existing chemical is below the ambient limit (workplace standard - safety factor), it can be assumed to exert no toxic effect. If the air concentration is above the ambient limit, however, it is not assumed to be a hazard per se, but a condition that warrants further investigation.

If workplace standards are to be used in assessing the indoor environment, the standards should be reviewed and modified as appropriate to account for the more susceptible members of the school population and for exposure to multiple pollutants. Again it is important to remember in a public health situation if detected concentrations of a substance exceed the occupational exposure limit, an indoor air quality problem is evident. Detected concentrations below the workplace standards should not be construed to mean an indoor air quality problem does not exist.

In these cases, additional research into the occupational standard's background documentation or data interpretation from qualified individuals would be recommended. Workplace standards are frequently divided by a safety factor of 10 to account for more susceptible individuals. There is no consensus on how to handle multiple exposures. The true interaction between pollutants may range from protection (one pollutant protects against the effects of another) to synergism (the total effect is greater than the sum of the effects taken independently). The safety factor of 100 has been used by others to account for all the special considerations mentioned above.

The safety factors that states use are applied generically. That is, the same safety factor is applied to a large group of chemicals, generally with little or no regard to toxicity or mode of action within the human body. If the air concentration on the existing chemical is below the ambient limit (workplace standard - safety factor), it can be assumed to exert no toxic effect. If the air concentration is above the ambient limit, however, it is not assumed to be a hazard per se but a condition that warrants further investigation. Using these "air toxics" limits in this manner provides a "screening" approach. Maryland is currently using this approach informally and has adopted regulations which incorporate this concept.

CONTROL METHODS

Control methods are an important means of alleviating indoor contaminant problems. There are six basic methods for lowering concentrations of indoor contaminants. Each **appendix** suggests the methods that are most applicable to the contaminant in question. The summary listing below is provided to facilitate an understanding of all the options available.

1. **Filtration and purification of contaminants** are employed where specific problems exist and affordable devices are available. Particulate filtering is a highly advanced technology, but increased performance can involve significantly higher costs. Ordinary furnace filters are not effective in capturing pollen and other small particles. Higher performance filters are available at higher costs. Vapor and gas removal equipment is also available, but the technology for general use in ordinary occupied spaces is expensive. Activated charcoal filters, which vary in efficiency and holding capacity, are used to adsorb high molecular weight gaseous molecules, usually at costs in linear relation to their performance. However, it is difficult to determine when the filters are loaded with dust and dirt, and they can release (desorb) lighter molecules previously adsorbed. Certain chemicals are available to oxidize or change particular gases and vapors into other, less hazardous or odorous forms. Refer to ASHRAE Standard 52-1976 for details on filter specifications.

2. **Removal or substitution** of materials that contribute to indoor air problems is usually the most effective control method. The pro-active approach is to identify these materials before they are introduced into the school and provide satisfactory substitutes. Such materials include some paints and other finishes, manufactured wood products, plastics, pesticides, and cleaning and maintenance materials. Some manufacturers have, as a part of their manufacturing process, a "curing" time to allow for factory outgasing of pollutants prior to delivery.

3. **Ventilation** is a commonly used method for controlling indoor contaminants. Usually it is employed to 1) dilute the indoor air with quantities of outdoor air that are presumed to be less contaminated (dilution ventilation), and 2) to exhaust contaminated air at the source (local ventilation). In buildings with mechanical ventilating systems, outdoor air quantities are provided by design at rates specified in the applicable building codes. Local exhaust fans should be employed to remove contamination near its source, such as in restrooms, studios, tobacco smoking areas, industrial art classrooms, and laboratories.

4. **Encapsulation** (or otherwise interfering with the materials' ability to give off pollutants) is another control method. If this method is used, a maintenance plan is necessary to ensure its continued integrity. This plan must include periodic inspections. The discussion of asbestos (**Appendix A**) as it pertains to the Management Plan might be the model for managing any encapsulated material.

5. **The time for use** of a possible contaminant is an important administrative strategy. Potentially detrimental products or activities such as disinfectants, paints, or maintenance activities should be used when the least number of people will be exposed.

6. **Education** of the building occupants is an important activity. If people are provided information about the sources and effects of contaminants, they can act to minimize their exposure. More people will limit their use of possible contaminants indoors when they understand the relationship between contaminants and indoor air quality.

NOTE TO INVESTIGATORS AND DESIGNERS

It is hoped that this information will equip the reader with some insight into the complexity of evaluating indoor air exposures and health effects.

The facility planner must understand a school will be used by large numbers of individuals who, because of age or health status, face an increased risk of experiencing adverse reactions to indoor air pollutants. Therefore, every effort should be made to anticipate possible sources of indoor air pollution and to take appropriate action. The design standards presented in **Appendix J** are an important reference prior to beginning the design process.

Likewise, the investigator should understand the peculiarities of the school population and the complexities of attempting to link health effects to indoor air pollutant exposures. Air monitoring data should be reviewed by appropriate health professionals. The investigator can use the above information, as well as that contained in the appropriate **appendices** at the end of this document, to help guide the investigation.

PLANNING AND DESIGN

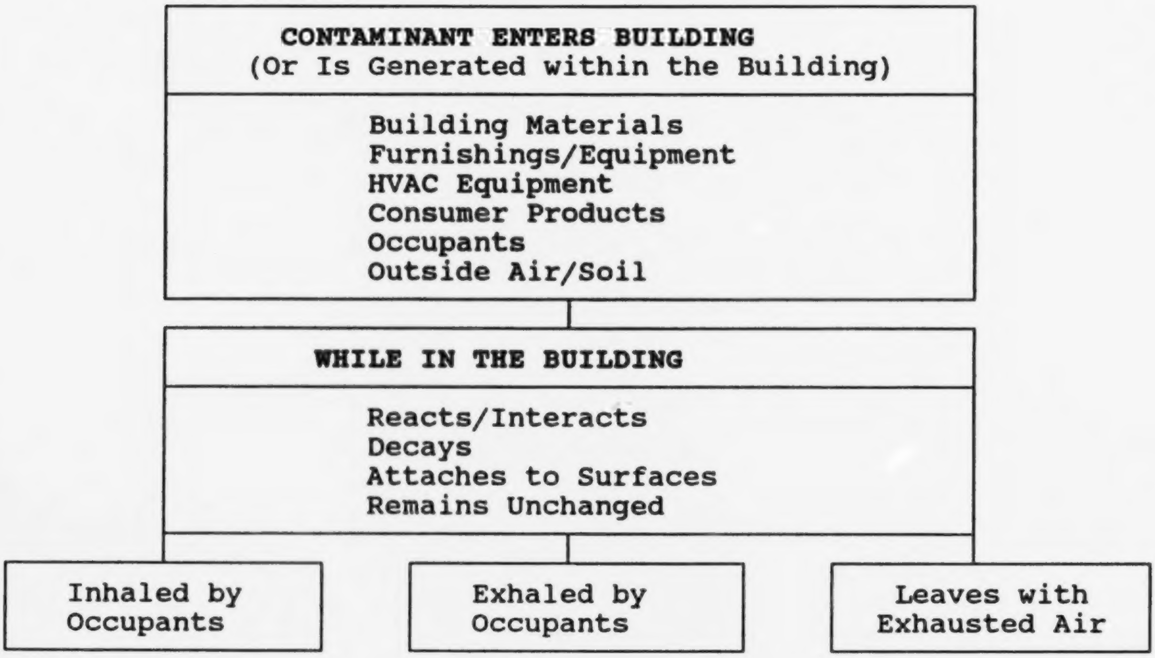
Like so many things, school air quality management begins in the planning and design phase of a project. If a school's HVAC system was never planned to bring in outside air, then it will be designed and, therefore, built to recirculate only the indoor air. When it is decided that outside air is needed to improve indoor air quality, such will be obtained only through retrofit of an existing HVAC system. The following provides the user with a discussion of the many considerations that should be addressed in the planning and design of a new or totally renovated school facility. (Please see **Appendix J**, Design Standards, for additional information.)

TEMPERATURE, HUMIDITY AND VENTILATION

Assessing the quality of indoor air seldom rests on a single contaminant or condition. Air flow in the occupied area can be nearly as important as the quantity of outside air coming into the school. Humidity that is too high or too low can affect the growth of biological contaminants or the human sensitivity to pollutants. Inadequate and/or non-uniform heating or cooling can contribute to indoor air quality problems. All these factors rest on the effective operation of the heating, ventilation, and air-conditioning system (HVAC) and how it is controlled.

The indoor pollutant flow shown in Figure 2 provides an overview of the contaminant's "life" in a school building.

Figure 2. Indoor Pollutant Flow


CONTAMINANT ENTERS BUILDING
(Or Is Generated within the Building)
Building Materials
Furnishings/Equipment
HVAC Equipment
Consumer Products
Occupants
Outside Air/Soil
WHILE IN THE BUILDING
Reacts/Interacts
Decays
Attaches to Surfaces
Remains Unchanged
Inhaled by Occupants
Exhaled by Occupants
Leaves with Exhausted Air

This figure suggests that several contaminants and conditions related to indoor air quality could be operating at any given time. This section looks at the roles played by temperature, humidity, ventilation, and the HVAC system in relation to this pollutant flow. It concludes with a discussion of ways to preserve energy efficiency while improving air quality.

HEATING, VENTILATION, AND AIR-CONDITIONING

The heating, ventilation, and air-conditioning systems (HVAC) today serve as the lungs of the school building, controlling the quality of air indoors. Teachers, students, and other occupants depend on the HVAC system for odor, ventilation, temperature and humidity control. It affects productivity, learning, and, most importantly, health.

Unless the HVAC system is well designed and maintained, outdoor contaminants can enter into a school building and jeopardize the quality of indoor air. Similarly, the system must filter or exhaust indoor pollutants or contaminant levels will increase. Poorly maintained HVAC systems can be a source of pollutants. Fungi and bacteria can grow in the condensate pans in HVAC units, and combustion contamination can result from cracks or leaks in the heating equipment or improperly vented exhaust. Additional information and references relating to HVAC systems appears in Volume II.

TEMPERATURE

Providing comfortable air temperatures for the majority of occupants depends on such varied factors as: the level of activity, age, physiology, clothing and preferred temperature of the occupants; the number of people in a room; the relative humidity and air movement in the building; and the contribution solar gain.

Recommended Temperature Ranges - A range of temperatures is usually given for the heating and the cooling seasons, and for specified portions of the building or level of occupant activity. Air temperature settings for areas of light, mostly sedentary activities in Anne Arundel County Public Schools are:

	Heating	Cooling
Elementary:	70°F	78°F
Secondary:		
Classrooms -	68°F	78°F
Hallways -	65°F	78°F
Special Education:		
Classrooms -	75°F	75°F
Hallways -	75°F	75°F

For the following specified areas, the temperature range should be:

Gymnasium:	
Elementary -	70°F (No cooling, ventilation only)
Secondary -	68°F (No cooling, ventilation only)
Pool Area/Therapy:	
Water Temperature	95°F year round
Air Temperature -	75°F year round
Ventilation Rate -	2 cfm per sq. ft. of floor surface
Kitchen:	None specified. Draw heat/cooling from appliances and the cafeteria.

Relationship of Temperature and Indoor Air Quality - Temperature will affect the off-gassing of some pollutants from building materials and furnishings, and in some environmental control systems, the rate at which outdoor air enters the building is a function of the indoor and outdoor air temperatures. Temperatures outside the comfort range are environmental stressors which effect human reaction and tolerability to other stressors, including indoor air contaminants.

HUMIDITY

The level of relative humidity (RH) affects the temperature ranges found to be acceptable by occupants. A combination of temperature and RH provides an "operative temperature" to help define comfort boundaries. Table J-1, page 123, taken from ASHRAE Standard 55-1981, describes the operative temperature ranges for lightly clothed sedentary adults.

Relationship of Humidity and Indoor Air Quality - The level of humidity affects the growth of some organisms and sensitizes occupants to certain pollutants. High humidity can accelerate the off-gassing of volatile organic compounds from building materials. Humidity that is above 60 percent can foster the growth of bacteria, viruses, fungi, and can encourage the growth of dust mites (which live on skin flakes and cause allergies in approximately 20 percent of the population). The 10 to 40 percent range can provoke respiratory problems, allergies, and chemical sensitivities. The optimum range for relative humidity is 40 to 60 percent in summer, and 30 to 50 percent in winter.

VENTILATION

The term ventilation refers to the outside air that is deliberately brought into or exhausted from a school building as well as the air movement within the facility. Air that comes in through cracks or other openings in the building envelope (infiltration) add to the amount of outside air entering the building. With the advent of the energy efficient, or "tight" buildings, the drop in infiltration has made mechanical ventilation a more critical factor.

Acceptable Ranges - Air exchange rates are usually prescribed in cubic feet per minute (CFM) per person or per square foot. With the energy crisis of the 1970s, the amount of outside air in schools was generally reduced to 5 CFM/person. As concerns regarding the quality of indoor air have emerged, serious consideration is now being given to raising that standard. ASHRAE is in the process of revising its Standard 62-1981, Ventilation for Indoor Air Quality. New or renovated schools will be designed to ASHRAE proposed Standard 62-1981R of 1988 or as later revised, see Table J-2 on page 125. Standard 62-1981 is no longer acceptable. The user is referred to **Appendix J** for additional guidance and other design considerations.

Implications for Indoor Air Quality - Dilution through increased outside air offers a means of mitigating some contaminants. Increased outside air beyond the ASHRAE standards may be beneficial when the contaminant or its source is unknown, or as an intermediate step until action can be taken. Where the cost to remedy a situation is deemed too high, or where more ventilation is determined to be the most effective means of mitigating the problem, dilution is a viable alternative.

It should be kept in mind that going beyond the ASHRAE standards for outside air is one of many alternatives available, and decisions should consider many important factors, such as:

1. the quality of the outside air;
2. the ventilation efficiency; (i.e., the ratio of the amount of outside air to the air actually reaching the occupant);

3. the fact that increased air changes per hour (ACH) have little or no direct correlation to the contamination level of some pollutants, such as formaldehyde. (In extreme cases, such as with radon, increased ACH can actually increase contaminant levels.)
4. increasing the introduction of outside air may be a costly remedy. The cost of conditioning (heating/cooling) the air and moving it within the facility usually represents a significant portion of a school's utility bill. Increasing ventilation not only adds to the higher costs of heating/cooling, but the power required for an air handler motor to move more air is the cube of the flow rate. For instance, if it takes 1 hp to move 1,000 CFM through a certain duct, it will take 8 hp to move 2,000 CFM through the same duct.

Increased ventilation is a frequent treatment of indoor air pollution and is an important consideration, particularly as a short term measure. It is important, however, to remember dilution through ventilation is not elimination. Ventilation reduces the level of exposure to some contaminants, but chronic low level exposure may still exist. Long term health concerns may persist. The first mitigation step for indoor air pollution should be removal/substitution at the source wherever feasible.

ENERGY EFFICIENCY AND INDOOR AIR QUALITY

Many possibilities exist for improving indoor air quality and cutting utility bills, such as replacement of water damaged insulation, routine replacement of filters, central heating equipment repairs to prevent combustion contamination, certain maintenance activities, humidity control, which reduce the likelihood of mold while contributing to comfort and energy, and improved air distribution.

Ventilation appears to be a key ingredient of many cures - both in the amount of outside air and distribution where needed. But temperature and humidity control, energy management system operation, proper decentralized heat pump system design, elevated chilled water temperatures, ventilation-starved VAV interior zones also have roles. Ventilation, temperature, and humidity concerns vis a vis indoor air quality cannot be considered separately. Some pollutant concerns stem from poor HVAC system design, installation or operation, and some relate to poor maintenance of those systems. In some instances there is a detrimental relationship between temperature, humidity, ventilation and certain contaminants. Other sections of this manual, which speak to these matters, are vital to understanding the roles temperature, humidity and ventilation can play.

LEASED BUILDINGS

Any building that is being considered for lease by the Anne Arundel County Board of Education must now have a pre-lease indoor air quality inspection. The inspection will be conducted by trained Anne Arundel County Board of Education staff following the procedure outlined in this model program.

The inspector will identify any existing or potential indoor air quality problems. His report will suggest those corrective actions requiring implementation prior to occupancy of the building and any maintenance or operations procedures required after occupancy. The above requirements are made a part of the lease agreement, with the responsible party (building owner or board of education) clearly stated. Reinspection of the building every three years by board of education staff will be part of any long-term lease agreement.

Any corrective action or maintenance/operations procedures under the building owners responsibility must be conducted by qualified personnel. The building owner is required to document worker qualifications through training and experience. If the building owner is solely responsible for maintenance and operations, their staff or the contractors personnel must attend the Anne Arundel County indoor air quality course for general maintenance and operations staff as outlined in the training section of this model program.

Any building owner responsible for maintenance and operations is required to maintain records at the building. These records must include a description of the actions to be completed, the frequency required, the start and finish date of each action, and the name, address, and signature of the person completing each action.

TRAINING, EDUCATION, AND INFORMATION

A fundamental ingredient of all indoor air quality programs is the requirement to provide essential training, education and information.

Training is necessary at several levels, and the content of the training must be adjusted to meet the needs of these different levels. There is first the detailed "hands on" training necessary to prepare workers to safely and effectively perform their day to day tasks, handle potentially hazardous material, or deal with any problem that may arise. Next, there is there training necessary for supervisors and building administrators. They must not only know what is required of the workers, but must know what and how to inspect, and what steps are necessary in responding to emergencies. Finally, there is the training necessary for other staff and occupants of the building. They must know how to report suspected problems and how to respond in the event of emergency. Many of the recent regulations regarding indoor air quality issues cite specific training requirements necessary for compliance. These requirements are contained in the Appendices to this document as they apply to specific indoor air quality issues.

A significant recent trend is the use of criminal enforcement as a mechanism for ensuring compliance with environmental laws and regulations. Individuals at all levels are now being fined and criminally charged. Ignorance of the law is no longer an excuse. Courts are now ruling that constructive knowledge or the "should have known" concept is sufficient cause for prosecution. Proper training at all levels is therefore essential. First, because the law requires it, and secondly, it is the best protection against costly mistakes that could result in a safety or environmental problem, great expense, possible penalties and criminal liability.[4]

Education is an extremely important element in any indoor air quality program. Employees, administrators, supervisors, teachers, and parents all need to be educated regarding the requirements contained in the applicable laws and regulations, the actual hazard (if any) posed by the IAQ problem, and the program established by the school system to deal with IAQ concerns. Finally, there is an absolute requirement for timely and accurate information dissemination. All employees, administrators, supervisors, teachers and parents should be kept advised as problems are identified, test results or other data become available, remedial actions taken and programs initiated. Such information must be available at the school level and must be accessible. Parents may be kept informed through newsletters, meetings, notices in community papers or other means. Sharing of information, accompanied by a responsible program to deal with the problem, will instill confidence and avoid community overreaction, and mistrust. Cooperation with local health department officials is also critical and needs to be part of the information process.

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[4] Environmental Managers' Health & Safety Handbook; Government Institutes, Inc.; 1988.

The chart listed below depicts the Indoor Air Quality related training requirements for the employees of the Anne Arundel County Public School System.

Employee Training Plan

\TRAINING EMPLOYEE\	PGM 1	PGM 2	PGM 3	PGM 4	PGM 5	PGM 6	PGM 7
BOARD / SUPT & EXEC STAFF	XX						XX
SR SUPERVISORY STAFF	XX	XX	XX	XX			XX
BLDG ADMIN'R / BUSINESS MGR		XX	XX	XX			XX
P & E OPERATOR/ CHIEF CUSTODIAN		XX	XX	XX	XX	XX	XX
CUSTODIANS		XX	XX	XX	XX		XX
MAINTENANCE MEN		XX	XX	XX	XX	XX	XX
SPT PERSONNEL (SCHOOL BASED)		XX	XX	XX	XX		XX
TEACHERS			XX	XX	XX		XX
PROF SPT STAFF (CENTRAL OFC)			XX	XX	XX		XX
IAQ INSPECTORS/ INVESTIGATORS			XX	XX	XX	XX	XX

TRAINING PROGRAM CONTENTS:

PROGRAM 1:	Executive Environmental Briefing (2 Hours)
PROGRAM 2:	Indoor Air Quality Basic Course (4 Hours)
PROGRAM 3:	AHERA Orientation (2 Hours)
PROGRAM 4:	Hazard Communication Standard "Right To Know" Orientation (1 Hour)
PROGRAM 5:	Hazard Communication Standard "Right To Know" Individualized Training (As Required)
PROGRAM 6:	IAQ Inspectors and Investigators (8 Hours)
PROGRAM 7:	Specialized Training (As Required)

Note: Persons whose jobs require specialized licensing, knowledge or skills will be provided necessary training. Included in this category are the AHERA Designated Person, Asbestos Workers, Pesticide Applicators, and so forth.

Do you have an explanation for these symptoms? (for assistance, review Frequently Encountered Problems on page 37) Yes ____ No ____

If yes, what is the cause?

What is the recommended solution and time frame?

A. Actions to be taken in the area affected (e.g., discontinue use of materials):

B. Actions to be taken by maintenance personnel (e.g., increase ventilation, unclog air intake, repair thermometer):

C. Other actions:

If none, what is the next step (this is a matter of judgement for the investigator)?

____ Monitor for several days to determine if the problem continues.
____ Initiate further evaluation.

Signatures: Investigator: ______________________ Date: ______________
Principal: ______________________ Date: ______________

FOLLOW-UP: (complete A or B as appropriate)
Follow-up should take place 1-3 months after the initial response or 1-3 weeks after the action plan is completed. Continuous communication should be maintained with the reporter(s).

A. This problem has been solved:

Signatures: Investigator: ______________________ Date: ______________
Principal: ______________________ Date: ______________

The course outlines for the Indoor Air Quality Basic Course and the IAQ Investigators and Inspectors Course are shown below:

INDOOR AIR QUALITY BASIC COURSE

Introduction (30 Minutes)

Historical Perspective (30 Minutes)

Factors Which Affect Indoor Air Quality (60 Minutes)

- Thermal Comfort
    - Temperature (radiant/ambient)
    - Relative Humidity
    - Air Movement

- Air Contaminants
    - Chemical
    - Biological

- Psychological

The Anne Arundel County Public School System's Indoor Air Quality Program (60 Minutes)

Hazardous Materials Management and Control (30 Minutes)

Preventative Maintenance of Building Systems (20 Minutes)

- Building Maintenance

- Building Inspection

- Changes in Building Use

Summary (10 Minutes)

IAQ INVESTIGATORS AND INSPECTORS COURSE

Introduction (30 Minutes)

Historical Perspective (30 Minutes)

Factors Which Affect Indoor Air Quality (60 Minutes)

- Thermal Comfort

  - Temperature (radiant/ambient)
  - Relative Humidity
  - Air Movement

- Air Contaminants

  - Chemical
  - Biological

- Psychological

The Anne Arundel County Public School System's Indoor Air Quality Program (60 Minutes)

Hazardous Materials Management & Control (60 Minutes)

- What are Hazardous Materials?

- Regulatory Requirements

- Inventory of Hazardous Materials and Material Safety Data Sheets

- Contaminant Control at Source of Generation (vacuuming, local exhaust)

Preventative Maintenance of Building Systems (120 Minutes)

- Maintenance Scheduling

- Building Inspection (qualitative & quantitative)

  - Temperature
  - Humidity
  - Wet Materials
  - Presence of Mold
  - Inadequate Lighting/Glare
  - Noise
  - Dust Particles
  - Odor
  - Other Potential Sources of Contaminants
  - HVAC Systems (condensate pans, filters, local exhaust controls, location of air intakes, setting and operation of dampers)
  - Plumbing System (drains, pipe leaks)

- Building Inspection (qualitative & quantitative) continued:
    - Structure (roofs, painted surfaces)
    - Electrical Systems (transformers, light ballasts, lighting)
    - Furnishings (carpets, ceiling tiles)
    - Evaluating the Inspection Data
    - Developing a Plan of Action
- Changes in Building uses

Investigating an Indoor Air Quality Problem (100 Minutes)

- Preliminary Investigation
    - Optimal Approaches
    - Symptoms Questionnaire
    - Building Conditions Survey (potential sources of contaminants; evaluating the HVAC system)
    - Investigator's Assessment
- Additional Studies
    - Sampling for Specific Air Contaminants
    - Evaluating the Adequacy of the HVAC System
- Case Studies
- Follow Up

Summary (20 Minutes)

INVESTIGATION OF AN INDOOR AIR QUALITY PROBLEM

This section is designed to respond to reports of indoor air quality problems. It is aimed at acute symptoms, such as headache and mucous membrane irritation, most commonly caused by poor indoor air quality. Two forms are present on the following pages, a short form and an extended form. The short form is to be used for investigations with an obvious source of the problem. The extended form should be used when the cause of the problem is not immediately apparent to the investigator. The purpose of these forms is to provide a mechanism for school system staff to quickly investigate and solve indoor air quality problems with their own resources whenever possible. A prompt visit is the key to identifying many sources and to maintaining good relations with the people experiencing the problem.

The investigation begins when symptoms are reported. If symptoms appear to be serious, life-threatening, or likely to cause long-term health damage, it may be necessary to bring in an outside consultant immediately and move very rapidly through the investigation while taking immediate steps to protect faculty, staff, and students. This may include building evacuation. This investigation process does not replace a disaster plan such as would be required for a chemical spill near a school nor does it address long term hazards.

The forms should be filled out at the site of the problem. Primarily two individuals are involved: the "reporter" who is the person who has recognized the problem and the "investigator" who is assigned to evaluate the problem. When the form is completed, it should be filed at the central office and at the school.

Once a strategy has been designed to identify and/or solve the problem, outside assistance may be obtained, if needed. Consultation may be available from the public as well as the private sector and could involve medical diagnosis, air pollutant monitoring, and/or HVAC system evaluation and redesign. Previous work should clearly define what tasks a consultant is to perform, the techniques to employ, the anticipated product, and how it will aid the solution. Every building is different and needs for consultation must be considered on a case-by-case basis.

Investigation of an Indoor Air Quality Problem[5]

(Short Form)

Date/Time Notified: ______________________ Who Reported: ___________________________

Position: ____

Building Name: ____

Building Location: ____

Designated Investigator: _______________________ Position: ____________________________

On-Site Evaluation: Date: _______________________ Time: ______________________________

People Present: ____

Reporter: Describe the problem, including symptoms:

Investigator: Is there an obvious cause of the problem? If so, record the source and describe your assessment and plan of action:

Signatures: Investigator: ____________________________ Date: ______________________

Principal:______________________________ Date: ______________________

If there is no obvious cause of the problem, proceed to the following extended form.

---

[5] The source for the following information has been extracted from "INDOOR AIR QUALITY: Maryland Public Schools," State Department of Education, 1987.

Investigation of an Indoor Air Quality Problem
(Extended Form)

Symptoms Questionnaire
Complete this questionnaire for each person affected (use additional pages as required).

Name of person: ______________________________

Specific building locations(s) involved: ______________________________

Date: ______________ Time: ______________

Person administering questionnaire ______________________________
self-administered)

Do you have a history of allergies? If yes, describe the type of problem, when it occurs, and any medication you take:

Check any symptoms you have experienced since the beginning of the school year. Estimate and check the number of days you have had this symptom.

	0-24 Hrs	24 Hrs-1Wk	1-4 Wks	>4 Wks
( ) Headache	( )	( )	( )	( )
( ) Dry Mouth	( )	( )	( )	( )
( ) Dizziness or	( )	( )	( )	( )
Faintness	( )	( )	( )	( )
( ) Difficulty	( )	( )	( )	( )
Concentrating	( )	( )	( )	( )
( ) Eye Irritation	( )	( )	( )	( )
( ) Hoarseness	( )	( )	( )	( )
( ) Fever	( )	( )	( )	( )
( ) Burning of the Nose	( )	( )	( )	( )
( ) Throat Irritation	( )	( )	( )	( )
( ) Nasal Congestion	( )	( )	( )	( )
( ) Coughing	( )	( )	( )	( )
( ) Skin Irritation	( )	( )	( )	( )
( ) Too Hot	( )	( )	( )	( )
( ) Too Cold	( )	( )	( )	( )
( ) Other (describe):				
	( )	( )	( )	( )
	( )	( )	( )	( )

Have your symptoms occurred ( ) Continually ( ) Intermittently

Did you have any of these symptoms during the last summer or school year? If yes, name them:

____

____

____

If you checked any symptoms, please describe them in more detail:

Have you sought medical attention for these symptoms? Please describe:

During which months are you likely to experience symptoms? (Circle all that apply):
J F M A M J A S 0 N D

During which days of the week are you likely to experience symptoms? (Circle all that apply):
M T W Th F S

During which part of the day are you likely to experience symptoms? (Circle all that apply):
a.m. p.m. All the time Anytime

What are the weather conditions when you experience symptoms?

( ) Rainy, stormy	( ) Calm, mild	( ) Windy
( ) Dry	( ) Hot, humid	( ) Cold

How long have you worked/attended school in this building?

After you began work or started school in this building, how long was it before symptoms started?
(Circle one): right away days weeks months years
Symptoms began before I was in this building

If you leave the building, do your symptoms improve? Yes ___ No ___ If yes, how rapidly:
minutes hours overnight days

Do you smoke? Yes ___ No ___

Are you bothered by cigarette smoke? Yes ___ No ___

Have you detected any odors? Describe:

What do you think is the cause of your symptoms:

Potential Sources of Indoor Air Quality Problems

The investigator may complete this section to the extent necessary to identify a likely source of contamination.

There are many potential sources of indoor air pollution, many not immediately apparent. This questionnaire will assist in the recollection of events that may have contributed to exposure to specific pollutants. This should be a "brain-storming session" with the investigator collecting all possible information and not trying, yet, to judge its relevance to the present problem.

If appropriate, sketch the affected area including equipment, activities, lighting, intake and exhaust ducts, room dividers, and windows. Also include the adjacent rooms and spaces (e.g., science classroom). If the space below is insufficient, attach your drawing.

Does this area or a nearby area have:

( ) Motor vehicles
( ) Arts and crafts
( ) Animals
( ) Garbage storage
( ) Science
( ) Cigarette smoking
( ) Duplicating machine
( ) Ind. arts/voc. shops
( ) Other ___________

Has there been any:

( ) New construction
( ) Pesticides used
( ) Painting
( ) Installation of carpets
( ) Cleaners used
( ) Other ___________

Is there any evidence of:

( ) Water damage or stains
( ) Inadequate lighting/glare
( ) Mold growth
( ) Noise
( ) Dirt around air ducts

Equipment, Materials, Supplies

List equipment, materials and supplies that have been introduced or modified, or whose emissions are not being removed.

a) Equipment:

Type, brand, model number	Date installed	Special comments
1.		
2.		
3.		
4.		
5.		

b) List materials used in this classroom or work area:

Material description or brand	Date of use	Special comments (any warnings on labels?)
1.		
2.		
3.		
4.		
5.		
6.		
7.		

c) List furniture, accessories, and the protective coating used. Include rugs, drapes, curtains, or other decorative materials.

Type	Material	Date introduced	Comments
1.			
2.			
3.			
4.			
5.			
6.			
7.			

d) List any chemicals introduced such as paints, surface coatings, floor, rug or fabric cleaners, deodorants, insecticides, and detergents, etc.

Type of material (Include brand)	Use	Last date used	How often used	Comments
1.				
2.				
3.				
4.				
5.				
6.				
7.				

Activities

a) List activities performed in this classroom or work area:

Activity	Usual schedule	Emissions from activity heat, odors, fumes
1.		
2.		
3.		
4.		
5.		
6.		
7.		

Episodic or Unusual Events

Building problems sometimes begin after events such as pipes breaking, roof leaks, etc. Describe any such events:

Event	When occurred	Comments
1.		
2.		
3.		
4.		
5.		

Evaluation of Heating, Ventilation, and Air Conditioning (HVAC) Systems

As needed, the investigator or a person knowledgeable about proper operation and maintenance of heating, ventilation, and air conditioning systems, should complete this section of the protocol. Often the HVAC system is the cause of an indoor air problem, delivering air that is the improper temperature or level of humidity or delivering too few air changes for human comfort. Also, improper maintenance can lead to mold growth, which may be the source of symptoms. It is important to have a way to identify these problems. In many cases, adjustments in the HVAC system will eliminate indoor air symptoms. When a point source is causing the problem, several solutions exist: the source can be eliminated, local ventilation can be installed, or alterations to the HVAC system may be necessary.

The following pages will allow you to systematically review the HVAC system and identify common types of problems.

In any investigation of a problem with the indoor environment, it is important to understand how the HVAC system in the building works and to document any recent changes that may have occurred in the HVAC system's design or operation.

It will be helpful to the investigation if, in addition to answering the general questions below, the investigator can obtain prints or diagrams of the HVAC system for the affected area. Also useful are descriptions of the building intake and exhaust systems and any other pertinent information.

1. Is the building served by one HVAC system or is the building divided into sections served by different units? Describe (include type of distribution system; e.g., VAV, dual duct, fan coil, etc.):

2. What type of heating is used for the building?

   a) On site boiler Yes ____ No ____ If yes, what type of fuel:
      Gas ____ #____ Oil Other ______________________________
      Approximate age of boiler ______________________________

   b) Central steam: Yes ____ No ____
   c) Electric: Yes ____ No ____
   d) Other ______________________________

3. Is accessory heating used in the affected area? Yes ____ No ____
If yes, please describe:
____
____

4. What type of cooling?:
( ) None ( ) Central ( ) Zone ( ) Individual Unit

5. Ventilation:
Can windows be opened? Yes ____ No ____
Is there a central ventilation system? Yes ____ No ____
Where is the fresh air intake with respect to any building exhausts? (e.g., boiler flue, kitchen exhaust, cooling tower, vent pipes)
____
____

6. Humidification/Dehumidification:
Is humidification equipment used? Yes ____ No ____
If yes, central ___ local ____? Describe (include type; e.g., steamjet, air washer, water spray, etc.):
Is dehumidification equipment used? Yes ____ No ____
If yes, central ____ local ____?

7. Filtration:
Describe type of filtration used (central and local):
____
____
____

8. Are the outdoor air dampers on air handling units fixed in the closed position or not providing outdoor air for another reason?
Yes ____ No ____

If yes, list each air handling unit and the space(s) served:
____
____

9. Are there other areas in the building that share the same conditioned air as the area where symptoms have occurred? Yes ____ No ____
If yes, there may be activities within these areas that could emit gases or aerosol forms of liquids and/or solids into the air circulated throughout the building. Based upon what you know about activities in the building, please list those which should be investigated.
____
____

10. Are there any sources outside the building, such as garages, industrial plants, restaurants, and dry cleaners, whose emissions can, under certain conditions, be taken in by the building ventilation system? List them:
____
____

11. **Are condensate pans in air handling units - draining?** **Yes ____** **No ____**
- clean? **Yes ____** **No ____**

12. **Were there any changes made in the heating, ventilation, and air conditioning system around the time of the incident? If so, describe them:**

____

____

13. Temperature/Relative Humidity (R.H.)

	Room	Date/Time	Temperature	R.H.
a)				
b)				
c)				
d)				

14. Carbon Dioxide (take measurement during peak occupancy):

			CO_2	
	Room	Date/Time	Room	Outdoor
a)				
b)				
c)				
d)				

Investigator's Assessment:
Review previous data collected. Summarize the main features of this problem and what you think are the relevant sources or HVAC information. This should be only a few paragraphs and should demonstrate the logic of your hypothesis as to what is causing the problem.

B. This problem has not yet been solved (describe the ongoing problem briefly):

____

____

Action planned and time frame (describe):

____

____

We have discussed the problem and recommend the above plan of action to evaluate and solve this issue.

Signatures: Investigator: ______________________ Date: ______________

Principal: ______________________ Date: ______________

Frequently Encountered Problems

1. Ventilation
   - Vents obstructed by furniture, partitions, etc.
   - Local exhaust improperly used/functioning
     - . Shop areas
     - . Arts and crafts
     - . Science labs
     - . Home economics
     - . Photo lab (acetic acid)
   - Loose fibrous glass insulation inside ductwork
   - Maintenance or repair of HVAC system
     - . Inadequate fresh air intake
     - . Improper air flows (check settings of dampers)
     - . Fans/blowers wired incorrectly
     - . Toxic solvents used to clean the system
     - . Inadequate air distribution
2. Volatile Organic Compounds
   - Paints
   - Cleaning fluids
   - Furniture stripping
   - Heating oil
   - Science lab
   - Auto repair (degreasers, cleaners, gasoline)
3. Fumes/Vapors
   - Welding
   - Auto, bus, truck exhaust
4. Thermal
   - High or low temperature
   - High or low humidity
5. Other
   - Formaldehyde
     - . Plywood and pressed wood products
     - . Carpet and glue
     - . Draperies, furniture, etc.
   - Carbon monoxide
     - . Boilers and furnaces
     - . Motor vehicle exhaust
   - Particulates
     - . Tobacco smoke
     - . Diesel exhaust
   - Molds
     - . In standing water
     - . On wet or damp surfaces

BUILDING INSPECTIONS[6]

The Anne Arundel County Public School System will inspect all buildings owned by the Board of Education for the purpose of identifying potential indoor air quality problems and recommending actions for each facility. When the action plans are implemented, the number of IAQ episodes should be reduced. Disruptions to educational programs will decrease and resources that would have been spent on unanticipated indoor air quality investigations can be put to other purposes.

Schools and other buildings will be placed in a priority order using the following criteria:

- complaints have previously been reported and an adequate solution has not been reached;
- complaints have not been reported but potential problems are known to exist; e.g., persistent roof leaks, HVAC equipment that is difficult to maintain;
- school buildings will have priority over administrative and other buildings;
- elementary schools will generally be given a higher priority than secondary schools due to the age group and the higher exposure time;
- multiple contaminant sources exist, e.g., vocational center; and
- other known or suspected conditions.

Buildings will be inspected as resources allow, but all building inspections will be completed no later than July 1992. All routine maintenance and operations procedures recommended in a building action plan will be implemented within three months of the plan's acceptance. Major capital cost items will be put in priority order and scheduled for completion as resources allow.

Inspections will be conducted during the heating season, generally between November and March under normal occupancy conditions. Atypical days with unusually high or low temperatures will be avoided. Only trained individuals shall conduct these inspections (see page 20, Training). The following equipment will be made available for use by inspectors:

- humidity/temperature indicator
- CO$_2$ monitor
- air flow monitor

The performance standards to be used by inspectors in evaluating data are as follows:

- carbon dioxide (CO$_2$): <1000ppm
- relative humidity:
  - winter/30-50% (in occupied spaces)
  - summer/40-60% (in occupied spaces)
  - < 70% in ducts and plenums
- air temperatures:
  - winter/68.5 to 75°F (at 30% RH)*
  - summer/73 to 79°F (at 50% RH)*
  - *these numbers assume light, mainly sedentary activity
- vertical temperature:
  - shall not exceed 5°F difference
  - between 4 and 67 inch levels
- local exhaust systems (face velocity)
  - minimum 100 fpm
  - or flow rate originally designed for in specifications

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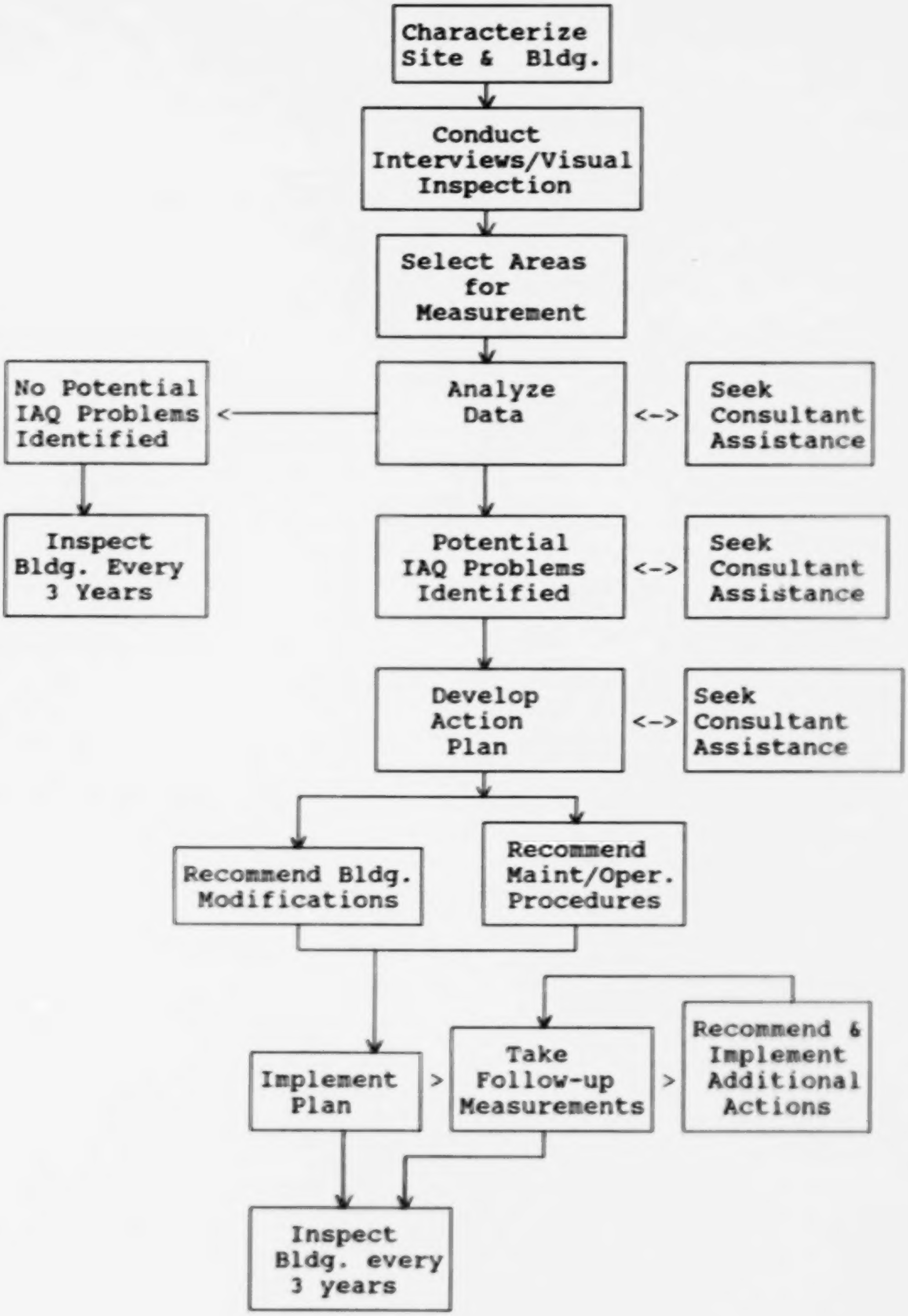
[6] In part, this section draws conceptually from "INDOOR AIR QUALITY DIAGNOSTICS," a training program developed by Honeywell, Inc.

Inspection Flow Chart


Characterize Site & Bldg.
Conduct Interviews/Visual Inspection
Select Areas for Measurement
No Potential IAQ Problems Identified
<
Analyze Data
<->
Seek Consultant Assistance
Inspect Bldg. Every 3 Years
Potential IAQ Problems Identified
<->
Seek Consultant Assistance
Develop Action Plan
<->
Seek Consultant Assistance
Recommend Bldg. Modifications
Recommend Maint/Oper. Procedures
Implement Plan
>
Take Follow-up Measurements
>
Recommend & Implement Additional Actions
Inspect Bldg. every 3 years

BUILDING INDOOR AIR QUALITY INSPECTION

This is a four step inspection procedure to collect information, determine potential indoor air quality problems, and develop an action plan.

Date/Time ______________________

Building Name ______________________

Building Location ______________________

Designated Investigator(s) ______________________

Position ______________________

Other People Present ______________________

Step I: Site and building characteristics (1 hour)

1. Site

. Identify (Check) Potential Sources of Contaminants:

Source		Comments
Adjacent Land Use	______	______________________
Roadways	______	______________________
Service Entries	______	______________________
Other	______	______________________

2. Type of building (elementary, middle/junior high, high school, vocational center, special education wing/center, administration, storage, other)

____

____

____

3. Total gross sq.ft.

Yr. ____________ Sq.Ft. ____________

____________ ____________

____________ ____________

____________ ____________

4. Number of Stories ________

5. Modifications and Maintenance Activities

	Type	Year	Comment
Bldg. Function			
Carpet			
Furniture			
Equipment			
HVAC			
Roof			
Painting			
Other			

6. Structure Type

____

____

7. Envelope Type

Roof ________________________________

Walls ________________________________

Floors ________________________________

8. Type HVAC Distribution System (e.g., variable air volume, distribution system, etc.)

____

____

____

9. Duct Insulation: Yes ____ No _____ If Yes, Internal ___ External ____

10. HVAC Functions

Heating _____

Cooling _____

Dehumidification _____

Humidification _____

Filtration _____

Outdoor Air _____

11. Briefly describe any previous indoor air quality investigations conducted at this school, including symptoms, problems identified and actions taken (or attach a previously completed summary report if available):

Step II: Walk through (2-3 hours)

The investigator does a visual inspection of the entire building looking at the following elements of the facility for indicators of potential indoor air quality problems. The investigator may select a sampling of rooms when several identical rooms exist; e.g., two classrooms of a six classroom wing.

1. **Temperature (without actual measurement)**

    Air temperature
    Floor/wall temperature
    Uniformity

Location(s) with potential problem

Room/Area/Entire Building	Problem
a. ____________________	____________________
____________________	____________________
	____________________
	____________________
b. ____________________	____________________
____________________	____________________
	____________________
	____________________
c. ____________________	____________________
____________________	____________________
	____________________
	____________________

2. **Humidity (without actual measurement)**

Location(s) with potential problem

Room/Area/Entire Building | Problem

a. ______________________ ______________________________

b. ______________________ ______________________________

c. ______________________ ______________________________

3. **Wet materials or water stains; e.g., ceiling tile, carpet, walls.**

Location(s) with potential problem

Room/Area/Entire Building | Problem

a. ______________________ ______________________________

b. ______________________ ______________________________

c. ______________________ ______________________________

4. Presence of Mold

Location(s) with potential problem

Room/Area/Entire Building	Problem
a.	
b.	
c.	

5. Inadequate Lighting/Glare

Location(s) with potential problem

Room/Area/Entire Building	Problem
a.	
b.	
c.	

6. Noise

Location(s) with potential problem

Room/Area/Entire Building	Problem
a. ____________________	____________________
b. ____________________	____________________
c. ____________________	____________________

7. Dust/Particles

Location(s) with potential problem

Room/Area/Entire Building	Problem
a. ____________________	____________________
b. ____________________	____________________
c. ____________________	____________________

8. Odor (attempt to identify source)

Location(s) with potential problem

Room/Area/Entire Building	Problem
a.	
b.	
c.	

9. Equipment/Materials

Identify any equipment; e.g., duplication machines, kiln, or stored materials; e.g., cleaning agents, photographic supplies, that are potential sources.

Location(s) with potential problem

Room/Area/Entire Building	Problem
a.	
b.	
c.	

10. HVAC System

- Check all condensate pans for proper drainage and cleanliness

  Location(s) with potential problem

	Room/Area/Entire Building	Problem
a.		
b.		
c.		

- Check all filters for accessibility and cleanliness

  Location(s) with potential problem

	Room/Area/Entire Building	Problem
a.		
b.		
c.		

- Check functioning of all local exhaust systems

Location(s) with potential problem

Room/Area/Entire Building	Problem
a. ____________________	____________________
____________________	____________________
	____________________
	____________________
b. ____________________	____________________
____________________	____________________
	____________________
	____________________
c. ____________________	____________________
____________________	____________________
	____________________
	____________________

- Locate fresh air intakes and check for operation and proximity to cooling tower, vent pipes, kitchen exhaust, boiler flue, etc.

Location(s) with potential problem

Room/Area/Entire Building	Problem
a. ____________________	____________________
____________________	____________________
	____________________
	____________________
b. ____________________	____________________
____________________	____________________
	____________________
	____________________
c. ____________________	____________________
____________________	____________________
	____________________
	____________________

- Check effectiveness of ventilation (the mixing of supply air to disperse contaminants and create a uniform air temperature throughout)

Location(s) with potential problem

Room/Area/Entire Building	Problem
a. ______________________	______________________________
______________________	______________________________
	______________________________
	______________________________
b. ______________________	______________________________
______________________	______________________________
	______________________________
	______________________________
c. ______________________	______________________________
______________________	______________________________
	______________________________
	______________________________

- Check coils and ducts (where accessible) for cleanliness

Location(s) with potential problem

Room/Area/Entire Building	Problem
a. ______________________	______________________________
______________________	______________________________
	______________________________
	______________________________
b. ______________________	______________________________
______________________	______________________________
	______________________________
	______________________________
c. ______________________	______________________________
______________________	______________________________
	______________________________
	______________________________

- Check humidification equipment for standing water or damp conditions in adjacent ductwork

  Location(s) with potential problem

Room/Area/Entire Building	Problem
a. ____________________ ____________________	____________________ ____________________ ____________________ ____________________
b. ____________________ ____________________	____________________ ____________________ ____________________ ____________________
c. ____________________ ____________________	____________________ ____________________ ____________________ ____________________

- Observe supply diffusers or adjacent ceiling surface for dirt

  Location(s) with potential problem

Room/Area/Entire Building	Problem
a. ____________________ ____________________	____________________ ____________________ ____________________ ____________________
b. ____________________ ____________________	____________________ ____________________ ____________________ ____________________
c. ____________________ ____________________	____________________ ____________________ ____________________ ____________________

11. Plumbing System

- Visually check for pipe leaks
- Inspect traps for potential back-flow

Location(s) with potential problem

Room/Area/Entire Building	Problem
a.	
b.	
c.	

12. Envelope

- Survey roof, walls and floor on grade for proper draining and existing or potential leaks

Location(s) with potential problem

Room/Area/Entire Building	Problem
a.	
b.	
c.	

Step III(a): Specific room surveys (2-6 hours)

The investigator selects several rooms or areas to take measurements of carbon dioxide, air temperature, air flow, and relative humidity. The rooms should be selected based on the following four criteria using data collected in Steps 1 and 2:

1. Having significant contaminate sources;
2. Having the most susceptible occupants based on the number of occupants, hours of exposure, and type of occupant; e.g., special education student, preschool student, elderly client in vocational program;
3. Having poor ventilation effectiveness; e.g., significant temperature, and contaminant differences throughout room; and/or
4. Having previous complaints from occupants.

Step III(b): Building data (1 hour)

The investigator collects relative humidity, temperature and flow data for the building's outdoor air, supply air, return air, and exhaust relief air.

Actual Measured Room Data

Date: ______________________ Time: ______________________

Inspector: ____

Room Name: ______________________ No. ______________________

Building: ____

1. Room characteristics
   Size ____________ sq.ft.
   Attach plan of room. Show dimensions of room and locations of all exterior walls (W), windows (WD), doors (D), supply diffusers (SD), return grilles (RG), local exhausts (LE), local heating devices (LH), local cooling devices (LC), sources of contaminants (C), and occupants (O). Label North, South, East and West directions. Record ceiling height ____(ft) and plenum height ________ (ft).

2. Measured Data

	Room Data	Outdoor Data
Dry Bulb (^{o}F)	______	________
RH (%)	______	________
CO_2 (ppm)	______	________
No. of People	______	

Supply diffuser	Temp (°F)	RH (%)	Flow (cfm)

Total cfm ________

Return Grille	Temp (°F)	RH (%)	Flow (cfm)

Total cfm ________

Local Exhaust	Velocity (fpm)	Area	Flow (cfm)

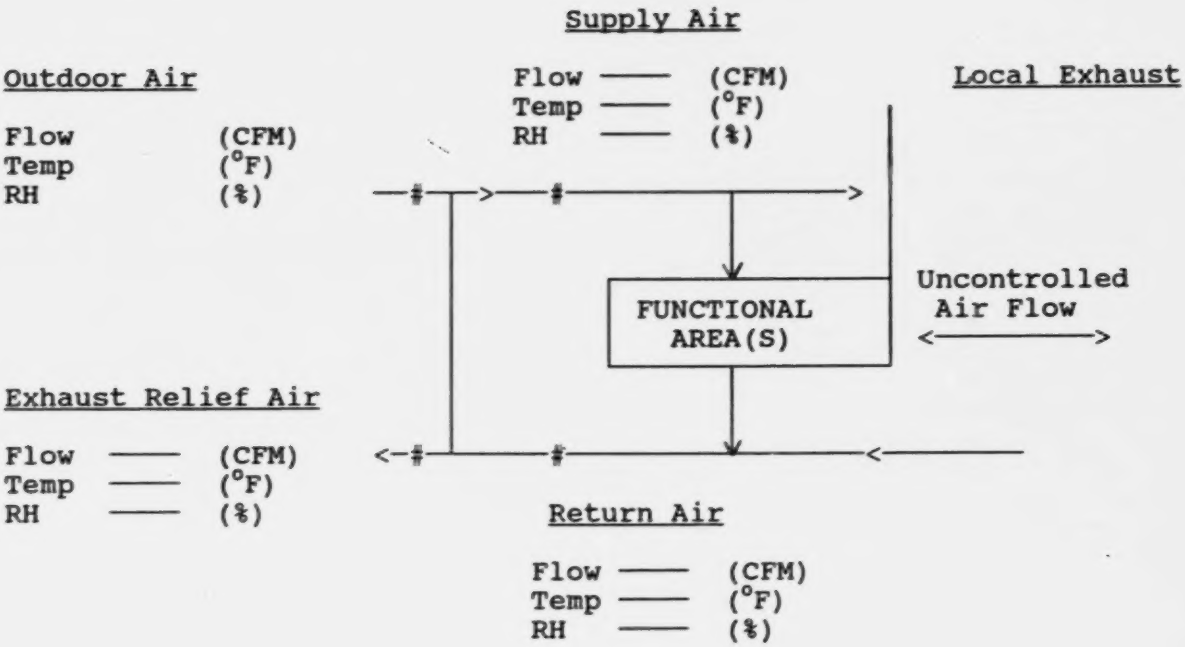
Vertical Temperature (°F)

Location	4 inches	67 inches	Difference

Outdoor Air (if local)

Flow ________ (cfm)
Temp. ________ (°F)
RH ________ (%)

Actual Measured Building Data


FUNCTIONAL AREA(S)
Uncontrolled Air Flow
<——————>

Outdoor Air

Flow (CFM)
Temp (°F)
RH (%)

Supply Air

Flow ____ (CFM)
Temp ____ (°F)
RH ____ (%)

Local Exhaust

Exhaust Relief Air

Flow ____ (CFM)
Temp ____ (°F)
RH ____ (%)

Return Air

Flow ____ (CFM)
Temp ____ (°F)
RH ____ (%)

1. **Summary of findings (describe each potential IAQ problem, the cause and/or source, and the rooms or areas affected):**

2. State what actions are recommended to correct each potential problem. Propose a time frame and present a cost estimate for each action:

3. Recommend any follow-up measurements that should be taken after completion of each action:

BUILDING MAINTENANCE AND OPERATIONS

Once a building has been constructed, responsibility for preserving good indoor air quality (IAQ) rests with the building operations and maintenance functions. **A comprehensive facilities maintenance program exists within the AACPS Maintenance Division.** It is used to manage scheduled maintenance, including an automated preventive maintenance program, scheduled repairs, minor alterations to facilities, as well as guide the reaction to unscheduled breakdown repairs and maintenance.

Both the AACPS Operations and Maintenance Divisions (O&M) are involved in the planning and design prior to the construction or major renovation of a school facility. This enables the O&M staff to understand the building systems as designed and installed. It also allows them during the design phase to call attention to design errors in A/E judgment or errors in the design itself.

PROGRAM MANAGEMENT

To implement a maintenance/operations program, three elements must be provided:

1. **Management support and commitment** from all levels of the organization, including the Board of Education;
2. **Staffing** by trained and competent personnel;
3. **Budgetary allocations** to provide the fiscal resources necessary to perform the comprehensive services required to maintain indoor air quality.

The following areas need to be addressed and documented in a written program:

Inventory

An audit of the condition of all buildings should be conducted as early as possible to establish a baseline for the physical plant. In addition to anticipating potential IAQ problems, an audit has value to all other aspects of operations and maintenance. The major building components that should be evaluated include:

1. Roof
2. HVAC (to include local exhaust systems in specialty areas)
3. Humidification
4. Incineration
5. Plumbing
6. Electrical
7. Basement/crawl space
8. Other Areas: Loading Docks
    Food Services
    Duplicating and Copy Rooms
    Teacher Lounges
    Gymnasiums-Pools
    Laboratories
    Storage Facilities
    Art Areas
    Theatre Crafts
    Automotive Repair Shops
    Industrial/Vocational Shops

Systems Description

Providing a description of each system is a particularly important, but often overlooked, program element. It is of crucial importance to both existing and new staff in the building.

Operational Plan

An operations manual should describe how to run the building systems. The plan should provide a detailed step-by-step procedure covering operation from start-up to shutdown. This document, an essential reference for day-to-day activities, will be a useful training document for new employees. A **vital part** of this plan should be a compilation of all available manufacturers literature and manuals.

The written operational plan should cover the building system instrumentation that will gather information or data on physical plant system performance. It should list design criteria; performance criteria; acceptable ranges for fluctuations in gauges, meters, and recorders, and trouble shooting strategies. Information on the frequency of both routine and preventive maintenance should also be included. Most, if not all, of this information is readily available from the manufacturers.

Comprehensive Preventive Maintenance Plan

Preventive maintenance (PM) is incorporated into AACPS's IAQ program. This system provides, on a programed frequency, PM cards informing the school based staff what is to be done on what piece of equipment in what time frame. The card is signed and dated by the person doing the PM as an incentive to perform the work on a timely and complete basis. This card is placed on file for future reference if required. The objective of this PM is to prevent small deficiencies from blossoming into major costly outages or repairs. For example, regularly oiling a bearing on a fan system will extend the useful lifetime of the unit, and prevent the potential loss of make-up or exhaust air that is necessary for adequate indoor air quality. The Table of Preventive Maintenance Tasks, see page 58, lists the PM tasks that are on AACPS's current PM program and most affect IAQ. The entire printout is available from the Maintenance Division. For those interested, contact a preventive maintenance project officer at (301) 255-2535. Administrators should spot-check the tasks in this Table to see they are being done. Technical assistance from the Operations Area Foreman should by requested in case of doubt or concerns.

Scheduling periodic maintenance can be an important determinant of indoor air quality. Both the frequency and timing are important. For example, biological growth of fungi and bacterial organisms have often been found in a unit window ventilator with condensation pans. In some environmental studies, these organisms have been shown to cause disease. Since school system unit ventilators run throughout the school year, they will accumulate biological growth as the year progresses and may disseminate biologically active aerosols to the building's occupants all the time. If the school system waits until June to clean and disinfect these units, they may pose a greater risk to building occupants than if they were disinfected several times during the year.

Preventive maintenance must be tied to a building's utilization schedule. Painting, coil cleaning, pest control or other projects involving the use of volatile organic chemicals should be scheduled when there are few, if any, occupants in the immediate vicinity. The work area should be well ventilated using fans wherever possible.

Preventive Maintenance Tasks (Table 2)

Item	Procedure	Frequency					
		DAILY	WKLY	MNTHLY	QRTRLY	SEMIANNUAL	ANNUAL
AIR HANDLING SYSTEM							
HEAT/COOL/VENT	CLEAN OR REPLACE FILTERS. CLEAN COILS & SPRAY WITH DISINFECTANT. CLEAN & FLUSH CONDENSATE PANS WITH DISINFECTANT AS NEEDED.		X				
	CHECK FILTERS. CLEAN IF NEEDED. CHECK CONDENSATE PAN DRAINS.	X					
	CHECK & CLEAN AIR INTAKE & SCREENING LOUVERS, ETC. CHECK OVERALL DUCT SYSTEM FOR CLEANLINESS, LEAKS, COLLAPSE				X		
	CLEAN HEAT & COOL COILS. CHECK & CLEAN FAN/BLOWER BLADES OF DIRT & TRASH BUILDUP.			X			
RETURN AIR FAN	CHECK & CLEAN AIR INTAKE SCREENING & LOUVERS, ETC. CHECK OVERALL DUCT SYSTEM FOR CLEANLINESS, LEAKS, COLLAPSE.			X			
	CLEAN FAN & BLOWER BLADES	X					
CABINET HEATERS	CLEAN & CHECK FILTERS AS NEEDED.		X				
	CLEAN OR REPLACE FILTERS. CLEAN COIL AND SPRAY WITH DISINFECTANT.	X					
PROPELLER UNIT HEATERS	CHECK & CLEAN COIL & FAN BLADES						X
FAN COOL UNITS	CLEAN & FLUSH CONDENSATE PANS WITH DISINFECTANT AS NEEDED.				X		
	CHECK & CLEAN FILTERS AS NEEDED.		X				
	CHECK & CLEAN COIL WITH SPRAY AND DISINFECTANT.				X		
CEILING FANS	CHECK & CLEAN FAN BLADES.				X		
UNIVENT UNITS	CHECK & CLEAN FILTERS AS NEEDED.			X			
	CHECK & CLEAN COIL AS NEEDED.				X		
	CLEAN OR REPLACE FILTERS. CLEAN COILS & SPRAY WITH DISINFECTANT.				X		
	CLEAN FAN BLADES & HOUSING.				X		

Preventive Maintenance Tasks (Table 2)

Item	Procedure	Frequency					
		DAILY	WKLY	MNTHLY	QRTRLY	SEMIANNUAL	ANNUAL
DUST COLLECTORS	CHECK & CLEAN DUST COLLECTOR CHAMBERS & DUCTS AS NEEDED.		X				
EVAPORATOR COOLER	CHECK FILTER CONDITIONS.			X			
	CHECK FILTER. CLEAN AD NEEDED CLEAN SUMP & STRAINERS.	X					
	DRAIN UNIT, CLEAN & FLUSH SUMP & STRAINERS. SECURE UNIT FOR WINTER.				X		
HUMIDIFIER	CHECK FILTERS. CLEAN SUMP AND STRAINERS.				X		
	LUBRICATE FANS & MOTOR BEARINGS.					X	
INCREMENTAL UNIT	CLEAN OR REPLACE FILTERS. CLEAN COILS AND SPRAY WITH DISINFECTANT. CHECK CONDENSATE PAN, CLEAN PAN & DRAINS, FLUSH WITH DISINFECTANT AS NEEDED.		X				
	CHECK & CLEAN FILTERS AS NEEDED.	X					
	CLEAN & CHECK COIL.				X		
ROOF TOP UNITS							
HEAT/COOL/VENT	CHECK OPERATION OF ROLL FILTER			X			
	CLEAN OR REPLACE FILTERS. CLEAN COILS & SPRAY WITH DISINFECTANT. CLEAN & FLUSH CONDENSATE PANS WITH DISINFECTANT AS NEEDED.		X				
	CLEAN ALL COILS.		X				
DRAINAGE SYSTEMS							
ROOF DRAINS	CHECK & CLEAN ROOF OR FLOOR DRAINS IN AREA.		X				
SANITARY TRAPS	OPEN & CLEAN ALL BUCKET TRAPS LEAD, GLASS, OR PLASTIC; IN SCIENCE & ART AREAS.				X		

Materials Management Program

It is important to understand that most chemicals used in housekeeping, maintenance, operations, pest control, and cafeteria services can affect air quality. Their use in the building should be properly managed. Material Safety Data Sheets (MSDS) are obtained from the manufacturers or distributors and should be on file in the school where any potentially hazardous material is to be or being used. If the MSDS is not available, a master file is kept in the office of the proponent (i.e., cleaning material MSDS with Operations, art supplies MSDS with the Art Coordinator, etc.). A school's population should not be subjected to unknown and potentially harmful effects of any material because of the absence of a MSDS. The Operations Division, (301) 647-7470, should be contacted if there are any questions on the MSDS program or the availability of a specific MSDS.

The chemical composition of hazardous ingredients must be evaluated along with the hazardous reaction potential. Wherever possible, materials, chemicals, and reagents that present the lowest toxic potential should be used. For example, if two floor strippers are evaluated, their solvent compositions should be compared on the basis of acute toxicity, concentration to be used in the task, and vapor pressure. Consideration must also be given to materials that present a risk of carcinogenicity, mutagenicity, or toxicity to a specific organ in the body. There are many authoritative sources available to help in this determination - the county Health Department, the Maryland Department of the Environment, and the school system's Office of Health Issues.

Less toxic materials should be substituted for more toxic materials. In general, water soluble materials should be given preference to organic solvent systems. Materials that are higher in flash point (ignition) and/or have a lower vapor pressure are also preferred. For example:

> Latex, water-based paints are less noxious than oil-based paints. If oil-based paints must be used, special low odor paints, time of use, and ventilation practices must be employed to reduce the potential IAQ effects on occupants. Because of this effort to reduce toxicity, a paint protocol (**Appendix I**) has been developed by AACPS. It is used to ensure all school interiors are painted in the safest manner possible by: 1) providing advance notice to schools and parents so children or staff with special needs can be accommodated; 2) using the least noxious paint possible; 3) reducing occupant exposure to paint solvent vapors by removing them from the area being painted; and 4) insuring adequate drying time with proper ventilation.
>
> Sulfuric acid-based drain cleaners have resulted in the emission of hydrogen sulfide gas in some institutions; sodium hydroxide drain cleaners might be preferable. In fact, school personnel should not use chemicals to clean out drains. If a clog needs to be cleared, the drain should be disassembled or a work request submitted to Maintenance. When a plumber clears a clog, for all but grease stoppages, a mechanical rooter is employed.

Pesticides

AACPS is committed to providing schools with a pest managed environment through the implementation of preventive hygienic methods and chemical strategies when necessary. Implementation of an Integrated Pest Management (IPM) strategy is under investigation. IPM emphasizes the use of nonchemical techniques for the management of pests, relying on the use of pesticides only when nonchemical strategies are not effective.

Each building owned by the AACPS will receive a yearly inspection for the purpose of identifying existing or potential problems that may contribute to harboraging, feeding or population growth. The inspector will recommend sanitation measures, structural changes, and other techniques to prevent problems before they occur. The inspector will also recommend monitoring when appropriate. Monitoring devices (traps) will be placed in the immediate problem area and in adjacent locations to assess migration, species, and population numbers. Threshold limits will be established for particular pests and areas of a building (e.g., five per trap for food service areas) so that an analysis of the monitoring reports, which include the number of traps, their locations, date of installation, date of pick up and body count can properly be done.

The inspector will recommend nonchemical pest control measures should preventive methods fail to control the problem. Finally, the inspector will list options for chemical treatments should the preventive and nonchemical measures prove to be unsuccessful. Less toxic chemical treatments will be given preference over the more toxic approaches. Pesticides with a label higher than "caution" will not be used with the exception of materials for termite control.

It must be noted that even the cleanest environment will not totally eliminate pest infestation. Pests gain access to buildings via receiving areas, cracks and fissures, and human transport. The IPM program may not prove as effective in some specific areas as would a chemical solution. This means that, in some instances, places such as receiving areas might be chemically treated to prevent further migration into the facility while the rest of the school would receive the non-chemical treatment. Each area must be identified and treated with the appropriate control method. A proper blend of chemical and nonchemical treatments should provide the ultimate pest control.

If pesticides are required, parents and staff should be notified through the school principal and two weeks in advance of the treatment. They will be provided with the name and telephone of the contact person should additional information be desired. If an occupant(s) has been identified as potentially sensitive to pesticides, administrative measures will be taken to reduce any health risk to that person. All schools will have available Material Safety Data Sheets (MSDS) for any pesticide to be used in that facility prior to application.

Chemical control treatment will be applied after school hours with the exception of emergency situations, determined **only** by the Supervisor or Assistant Supervisor of Operations. In the case of emergencies, such as a wasp infestation, all occupants will be removed from the treatment area.

All contract personnel will be required to possess a valid Maryland license before applying chemical pesticides. Operations Area and Assistant Area Foreman will be required to have training in the following areas:

1. Principles of IPM *
2. Preventive pest control measures *
3. Pest monitoring *
4. Nonchemical control techniques
5. Chemical pest control techniques
6. The known health effects of various chemical treatments

*Custodians will receive information in these areas through inservice training and newly employed through an Introductory Custodial course as a part of their orientation.

In all cases, care must be taken to minimize the quantities of potentially hazardous materials purchased, stored, and dispensed. Again, when in doubt, an expert should be consulted.

Roofing

Poorly designed or drained roofs may be a potential source of poor indoor air quality. Sooner or later roofs leak, offering support for biological growth and requiring extensive patching and greater maintenance. Roof pooling can also support biological growth. Architects designing facilities are directed to take special care to ensure that roofs are well designed and properly sloped. New schools or existing flat roof replacements should call for tapered insulation to introduce a slope to the roof system. Flat roofs invariably collect water. These roofs eventually leak, requiring extensive patching which involves the use of adhesives or tars. Commonly used adhesives are known to contain potent central and peripheral nervous system toxins. Roofing tars are known to contain sensitizing agents as well as carcinogens. These materials may be particularly harmful to young children.

Since these materials frequently enter the air intakes mounted on the roof, roofing operations should be undertaken when the exposure to building occupants is minimized. The best time to do this is when the school is unoccupied. Wherever feasible, enclosed tankers of tars should be used instead of open kettles to minimize the discharge of organic vapors. Roofing tar tanks should be located as far from air intakes as possible and preferably downwind from the building. If such measures are not feasible, then affected air intakes should be temporarily blocked while supplemental uncontaminated outside air is provided using portable fans.

In a roof replacement project, the potential for roofing material odors entering the school ventilation must also be considered. The A/E should be directed to specify in the contract documents a requirement for the contractor, prior to beginning work, to develop and submit for approval a ventilation plan as a part of his Quality Control Plan. Pre-construction meetings should have this topic as an agenda item.

Stagnant, standing water on roofs can support the growth of algae, bacteria, and possibly viruses that can be drawn into building air systems. Leaks in roofs result in water damage to, or accumulation in, ceiling tile, rugs, or internal wall spaces. Fungi and bacteria that develop in this moisture have been found to be responsible for allergies and respiratory disease. Consequently, when roofs are sloped inadequately or roof repairs are postponed, indoor air quality can easily be compromised. Water-damaged materials must be removed and replaced in a timely fashion before they serve as a breeding ground for biological growth. (See **Appendix K**, Roofing, for more information.)

In buildings that contain surface or acoustical asbestos treatments, water damage represents a particular health threat. Water can delaminate asbestos coatings, fireproofing, or decorative treatments. The weight of water-soaked asbestos may be sufficient to separate the coating from the substrate. Upon hitting the floor, free fibers of asbestos can be released into the room and distributed throughout the entire building.

Condensation Pans

Condensation pans must be periodically cleaned and checked to ensure that they are draining properly. This is an item on the existing PM system. Therefore, there is no excuse if, or when, a pan is found to be the source of an IAQ problem. The need to use an algecide is an indication of inadequate maintenance. Non-draining condensation pans can provide an ideal dark, moist environment for biological growth within air distribution systems.

Welding, Brazing, Cutting or Soldering

Maintenance operations, automotive repair, and theatre or craft procedures involving welding, cutting, soldering, and brazing involve toxic gases and particulates that should be vented outdoors. If, however, these operations cannot be done in such a controlled setting, then filtration must be used. To protect indoor air quality, a portable system -equipped with a high efficiency particulate air filter backed with an activated carbon filter - should be used. It is essential that such systems be equipped with a flexible capture hood to draw in environmental contaminants at their source.

Mechanical Systems

Pulleys, belts, bearings, dampers, heating and cooling coils, and other mechanical systems must be checked periodically. These, too, are on the existing PM system; so there is no reason they should be the source of an indoor air quality problem if the staff is following the scheduled PM.

Pulleys and belts should be tightened as needed and changed prior to failure. Bearings should be lubricated or repacked to prevent major failure of vital system components. Air distribution dampers and baffles should be cleaned and cleared of debris periodically. Failure to perform these activities will result in an increase in resistance, which causes a decrease in air supply.

The air distribution duct network should have access ports to allow the vacuuming of deposited dust and particulate matter. It may be necessary at some point in the building's lifespan to use a dilute solution of bleach (sodium hypochlorite 5%) to decontaminate the inner surfaces of air ducts. This procedure is particularly useful if tobacco combustion products have condensed on the interior surfaces of the duct, resulting in a "stale" air condition. This type of building maintenance task cannot be performed if the duct has an internal fibrous insulating lining. Therefore, interior duct insulation should be eliminated in all school buildings if at all possible.

Building ventilation distribution networks are systems that serve multiple locations. The common practice of arbitrarily adjusting the dampers or baffles to accommodate complaints from one area must be avoided. (See Volume II for a copy of an AACPS memo put out in the past year on this subject.) By changing the air flow in one area, the system balance is shifted and distribution throughout the entire network is affected. If there are distribution complaints, a test of the building's air handling system should be performed to confirm that the HVAC system and distribution network are in balance and are adequate.

Control mechanisms must operate correctly for a building ventilation system to function properly. Gauges must be in calibration, sensors must engage within their designated ranges, and transmission lines must not be defective. Pneumatic and hydraulic transmission lines should be checked for leaks. The control mechanisms should be included in the annual preventive maintenance program. They should be checked more frequently if the ventilation system does not perform as expected.

Vacuuming

Normal industrial vacuums emit particles and fibers in their exhaust. An improvement in performance can be obtained if they can be fitted with a high efficiency particulate air filter (HEPA). HEPA vacuums should be used in areas that might have spores or microorganisms. HEPA vacuum filtration ensures that potentially toxic or harmful aerosols are not dispersed while responding to a problem. HEPA vacuums are recommended for use in automotive and industrial shops and in craft activities that generate dusts, fumes, or particulates. Dry sweeping in these areas should be curtailed.

Electrical Transformers

Electrical transformers that contain polychlorinated biphenyls (PCBs) must be checked monthly and inspected for leaks. The EPA has estimated that the risk of a transformer fire is on the order of 4-5/1000 units over a transformer's lifetime. The operations and maintenance program should contain a plan either to dilute these units to PCB concentrations below 50 ppm or dispose of the liquid and metal casing. The EPA has enacted regulations requiring network transformers to be decontaminated, scrapped or ground fault protected of their primary and secondary sides by October 1, 1990. These regulations require AACPS to establish an inventory of transformers and capacitors (no capacitors exist), and requires transformer vaults be labeled and local fire departments be supplied with a list of the location and description of the electrical components containing PCBs. A log book of periodic inspections of transformer vaults will be maintained and an Annual Document (manifests documenting approved disposal) is required.

Operations and maintenance procedures have been put into place to maintain and manage properly these units until the threat of a fire or an uncontrolled PCB release can be eliminated. In FY88 five (5) transformers out of twenty-seven (27) were removed. In FY89, another $260,000 will be spent to continue this removal program. The final phase of this effort is in the FY90 Capital budget request. Ventilation to the transformer vaults has been examined to prevent toxic combustion products from being transported to the main areas of the building. Floor drains have been sealed in the vault areas. The O&M staff have a working contingency plan for handling fires or spills of polychlorinated biphenyls.

The EPA regulations do not specifically require that PCB fluorescent light ballasts be handled as hazardous materials. If, however, ballasts are removed in large numbers they should be dealt with as hazardous materials. Ballasts manufactured through 1978 may contain a small PCB capacitor. Ballast failure can volatilize both PCBs and the asphalt tar used to encapsulate the ballasts. Measurable quantities of PCBs have been documented by the EPA as long as a year after a failure. Asphalt tars have been associated with symptoms of upper respiratory irritation. AACPS is phasing out these items as repairs and modifications are made in the building's lighting system. Small quantities of ballasts are disposed of as ordinary solid waste after being placed in a sealed plastic bag.

Drains

Drains in laboratories must be kept clear and in working order. Sediment in drain traps can provide conditions that support the growth and accumulation of biological organisms. In laboratory areas, broken mercury thermometers have often led to the pooling of metallic mercury in the sink traps. This phenomenon can introduce mercury vapors into the indoor air. Acute exposure to plumbers and maintenance personnel must also be considered. Substitution of non-mercury thermometers and gauges in laboratories is an easy preventive solution to this problem.

The antisiphon traps in sinks must contain water to prevent noxious odors from the sanitary sewer lines from migrating back into the indoor air spaces. Sinks and drains that are used infrequently can dry out, allowing a path for gases to enter. Cupsinks in laboratory fume hoods and on benches frequently dry out and have often been found to be the sources of odors. This problem can be resolved and prevented by periodically running water in these drains, plugging unused drains with a rubber stopper, or using a nontoxic liquid with a low vapor pressure (such as ethylene glycol) to fill the antisiphon drain.

Building Use Changes

Special care must be exercised when building space utilization is changed. Renovation, redesign, or changes in building use can create situations that may lead to compromises in indoor air quality. For example, if a mimeograph or copy machine is brought into a small closet or other unventilated space, chemical emissions such as mineral spirits or ozone may suddenly become problems. The effect on heat and noise levels must also be anticipated if new equipment is added to an area.

A common renovation problem arises when additional personnel need to be accommodated in a space. Office or instructional areas are often partitioned and additional furniture and equipment installed. Anticipate the need to modify the air distribution in these situations. Conversely, when partitions are removed, creating new spaces, the ventilation distribution and balance must be revised. Care must be taken to ensure that, in the final layout, air supplies are located far enough away from the exhausts so that short circuiting does not occur.

Pipe Leaks

Pipe leaks can occur through corrosion, mechanical failure, or because of the expansion of water due to freezing temperatures. In any case of leakage, repair or replacement of the damaged pipe section must be performed immediately and the contaminated water be quickly removed and disposed of by pouring it into an appropriate drain. It is prudent to have wet vacuums, submersible pumps, squeeze brooms and mops available to handle water emergencies. Water damaged ceiling tiles, rugs, insulation or laggings must also be removed and replaced in a timely fashion to prevent mold from growing. Following storms, it is good practice to inspect the building for discolored ceiling tiles or leaks as signs of water problems. Pipes that may be subjected to subfreezing temperatures should be insulated to prevent freezing. The immediate spaces surrounding the pipes should be connected to the heated interior of the building.

Filters

Mechanical equipment for ventilation, heating, and air conditioning contain filter media or screens that minimize particulate matter from contaminating the coils, fans and interior housings, and ductwork. Originally, the primary consideration was to protect the system from contamination and loss in efficiency resulting in equipment shutdown and extensive cleaning. Recognition is now given to the role filters can play in improving indoor air quality.

Filters are primarily classified into three (3) types: mechanical filtration, adsorption, and electrostatic. Corresponding examples of each are as follows: fiberglass filters found in home furnaces; self-contained charcoal filter fans found in motel bathrooms; and large filter units usually placed on incinerators to remove charged particulate matter.

School systems are primarily concerned with mechanical filtration filters. Commonly used are replaceable fiberglass filter media, mechanical screen media that requires cleaning and recoating, and bag type filters. Filters are rated by efficiency, air flow resistance, and contamination holding capacity. The method of entrapment is by impingement that locks the particulates within the filter. Filters have a life expectancy rated in hours when used for a given air flow with expected contaminants. Severe dry spells that blow excessive dirt or interior dust-producing activities can increase contaminants reaching the filter.

AACPS has found that too often "permanent" metal filters are not being cleaned properly or at an acceptable frequency. Improper maintenance of these filters can have the following effects:

1) equipment efficiency is reduced and more energy is required to push the same quantity of air through the filter;

2) some contaminants pass through the overloaded filter, clog the coils, and enter the occupied spaces;

3) dirt collection on the coils diminishes the thermal transfer efficiency of the unit resulting in higher energy consumption; and,

4) contaminants on the coils become a breeding ground for bacterial and fungus growth,

AACPS has therefore decided on a program to replace all "permanent" filters with the fibrous disposable type. Filter replacement will be controlled through the existing PM program.

The above comments on air-handling heating units are applicable to all types of equipment containing ventilation, heating, and/or air conditioning coil systems. One must consider the expense of extensive cleaning to return this equipment to proper operations compared to the cost of replacing filters on a scheduled basis.

Because all filters are not equivalent, the Operations Division has been given the responsibility to procure all replacement filter media. This Division has the technical expertise to insure the proper filter media is specified. School administrators' responsibility is to spot-check to see that replacement is being done as scheduled by the PM program. Operations Area Foremen are available to assist upon request.

Record Keeping

While AHERA dictates a clear asbestos record keeping requirement, most other potential contaminants have no set procedure. Therefore, the following will apply to AACPS record keeping within the Maintenance Division. All records will be public in nature and available for examination.

Asbestos - All records must remain for forty (40) years after the asbestos has been removed as explained in the **Appendix A**. This includes maintaining and updating the Management Plans that are at all schools and the Local Education Agency (LEA).

Records to be kept include medical records, notifications, all abatement records (including air monitoring results), inspection records, certifications and any documents that may pertain to the asbestos in the facility. All records must be maintained at the main office of the school and the office of the designated person for asbestos.

Lead Paint - After tests for lead paint have been taken, they should remain in the building records until abatement has been completed. Also, abatement records should be part of that file for a period of ten (10) years. These records should be maintained in the school office and the Maintenance Division. Records will be made available to other AACPS offices upon request in preparation for major cleaning, demolition, or renovation projects.

Radon - There have not been any standards developed by EPA for the testing of radon. They are due the early part of 1989. When these standards have been developed, testing must be a part of the school and the maintenance file. This would include the initial inspection, laboratory field testing, follow-up inspections and testing, abatement plans, and the records of the work of outside contractors or consultants that might have been used.

Roofing, Painting, and HVAC Specifications (Design Standards) - The specifications, MSDS's of the products used and other information regarding these phases of work should be maintained in the project folder for a full life-cycle of the work in question. These Maintenance and Construction Divisions files should be used for future projects and as a reference.

All Other IAQ Problems - These should include records of the initial inspection, laboratory field tests, reinspections and other additional testing, action plans, any maintenance or operation activities that have been used to mitigate the problems, and any outside consultants or contractors that were used. These records should be maintained in the Maintenance Division file with copies of the investigation, actions taken and the retesting becoming a part of the school record. These records will be maintained for five (5) years.

USER COMMENT SHEET

TO: **Anne Arundel County Public Schools**
ATTENTION: Maintenance Division
9034 Fort Smallwood Road
Pasadena, Maryland 21122

Name: ______________________________

Address: ______________________________

Telephone: (   ) ______________________________

APPENDIX A

ASBESTOS

Introduction

Asbestos is found in thousands of commercial products including heat-resistant textiles, reinforced cement, special filters for industrial chemicals, thermal insulation, floor tiles, gaskets and brake linings. More than 725,000 tons of asbestos have been consumed in the United States alone in producing these products in each of several recent years. As a consequence of man's use of asbestos, a naturally occurring mineral, asbestos fibers are found in the air we breathe, the food we eat, and the water we drink.

1. Description:

Asbestos is a naturally occurring hydrated mineral silicate characterized by fibers or bundles of fine single crystal fibrils. Naturally occurring asbestos fibers typically have length to width ratios of the order of 100 and higher.

Included in the definition are the following materials:

- Chrysotile
- Crocidolite
- Amosite, and
- the fibrous varieties of Anthophyllite, Tremolite and Actinolite.

Commercially, chrysotile is the form used most. Crocidolite, amosite, and anthophyllite also have some commercial significance.

2. Sources:

Asbestos containing material commonly found in schools are:

a. floor tile
b. ceiling tile
c. boiler insulation
d. pipe insulation
e. breaching insulation
f. sprayed-on fire proofing

3. Health Effects:

Among asbestos workers, there is, in addition to the risk of asbestosis, an increased risk of death from lung cancer. Low level chronic occupational exposures have been associated with pleural and peritoneal mesothelioma, rare malignancies that are seldom found in persons without asbestos exposure. Asbestos has also been linked with gastrointestinal, oropharyngeal, and laryngeal cancer.

Association of Effects with Fiber Type

All types of commercial asbestos have been related to lung cancer in asbestos workers. In occupational groups exposed to chrysotile, crocidolite, and amosite, pleural and peritoneal mesotheliomas have been observed.

Dose-Response Relationship

Dose, as measured by severity and duration of exposure, relates to rates of cancer in groups exposed to asbestos.

The Cancer Latency Period

From all available evidence, the period between first exposure to asbestos and death from lung cancer appears to be related to intensity of exposure. Fifteen years is probably the minimum latency period for asbestos-related lung cancer. The peak increase occurs about 30-35 years after the onset of exposure.

Smoking and Asbestos-Related Cancer

In the general population, cigarette smokers have a 10-15 fold excess risk of lung cancer. One study observed an 8-fold excess of lung cancer among smoking asbestos workers compared with smokers in the general population. This suggests that the combined effect of smoking and asbestos exposure is greater than the simple sum of their separate effects. It seems clear that the increased risk of lung cancer in groups exposed to asbestos may be concentrated among those who also smoke.

4. Laws and Regulations:

-1982 Asbestos in Schools Rule to be in effect until implementation of the management plan. Other regulations include the Asbestos Hazard Emergency Response Act (AHERA), a congressional mandate for EPA to develop stricter regulations because school systems did not comply with the 1982 Asbestos in Schools Rule; OSHA-Construction; Industrial and Respiratory EPA; National Emissions Standards for Hazardous Air Pollutants (NESHAPS); and the Code of Maryland (COMAR).

APPENDIX A

Asbestos Hazard Emergency Response Act

EPA Responsibilities under AHERA

1. Promulgate regulations.
2. Establish model contractor accreditation program for states which includes inspections, management plan developers, and abatement contractors.
3. Administer financial assistance through ASHAA and Asbestos Trust Fund.
4. Appoint an asbestos ombudsman.
5. Study asbestos in public and commercial buildings.
6. Respond to citizen complaints about asbestos in schools.
7. Take emergency action to eliminate incidents of airborne asbestos.

Other Federal Agencies

1. Treasury Department - establish asbestos trust fund.
2. Department of Commerce; NBS - accredit laboratories.
3. Department of Labor - handle discrimination complaints.
4. Attorney General - legal and enforcement actions.

LEA Responsibility under AHERA*

1. Inspect for asbestos containing materials (ACM) as required by regulation.
2. Take response action as required by regulation.
3. Develop and implement an operations and maintenance program which shall be at least as stringent as the rule.
4. Develop an asbestos management plan and submit it to the governor (designee) for review.
5. Revise a disapproved management plan to correct deficiencies and resubmit to Governor.
6. Implement management plan by July 1, 1989.
7. Use transmission electron microscopy (TEM) for clearance.

*Regulations as developed by EPA, effective 12/14/87

State Responsibility under AHERA

1. Governor to provide notice to LEA as to where to submit management plan; establish any state administrative procedures to review management plan; designate state officials to review management plan.
2. Review management plan for each LEA within 90 days of receipt of plan.
3. Provide written notice to LEA if management plan is deficient, explaining reasons why plan was disapproved.
4. Review revision of deficient management plan, which LEA must re-submit within 30 days after original plan was returned.
5. Establish a contractor accreditation program which will be at least as stringent as the EPA model, and must cover:
   (a) Inspectors
   (b) Abatement Contractors
   (c) Management Plan Developers
6. Respond to citizen complaints about asbestos in schools.
7. Notify EPA administrator when Governor plans to take emergency action.
8. Take emergency action to eliminate incidents of airborne asbestos.
9. Work with State Attorney General's Office or United States Attorney General's office on Enforcement.
10. Submit to EPA a written statement regarding the status of AHERA compliance within that state.

5. Notification:
AHERA Regulations
AACPS Protocol

6. Measurements:
AHERA Regulations
AACPS Protocol

7. Standards and Guidelines:
AHERA (Table A-1, page 74, describes the AHERA Time Line of activities required to implement the law.)
NIOSH

8. Control Methods:
A) Encapsulation
B) Removal
C) Enclosure
D) Repair
E) Operations and Maintenance

9. Refer to AHERA:
A) Asbestos abatement options

10. For Further Information:

- AACPS, Mr. C. Thomas Leary, Environmental Program Manager, (301) 255-2535
- Maryland Department of the Environment, Office of School Asbestos Assistance, (301) 631-3834
- EPA Asbestos Action Program, Mr. Michael Stahl, (202) 382-3949
- EPA Hotline (24 hours) (202) 554-1404
- Maryland Department of Environment, Air Management Administration, Mr. Frank Whitehead or Mr. Doug Franz, (301) 631-3247
- Anne Arundel County Health Department, Air Quality Control, (301) 224-7360
- MOSHA, Public Sector Consultation, Mr. Ron LeClaire, (301) 333-4135; or 1-800-492-6226, ext. 4135

Table A-1

Ahera Time Line

October 17, 1986	Bill enacted by Congress
October 22, 1986	President Reagan signs Bill into Law
January, 1987	EPA to issue an advance notice of proposed rule making
April, 1987	EPA to propose regulations
April, 1987	EPA to develop model contractor accreditation plan for states
April, 1987	EPA to ensure all agency - approved asbestos courses are consistent with the model plan
October 30, 1987	EPA to promulgate proposed regulations
October, 1987	State Governor to provide notice to Local Educational Agencies (LEA) for submitting management plans to designated state agency
December 14, 1987	AHERA Regulation effective date
July 18, 1988	Public Law 100-368, extension of deadline for AHERA management plans passed
October 12, 1988	Deadline for submission deferral request
October 12, 1988	LEA to develop and submit management plans to the Maryland Department of the Environment
January 10, 1989	Deadline for state disapproval of management plan
May 9, 1989	Deadline for submission of management plans with AHERA extension for LEA with state approval
July, 1989	LEA to begin implementation of management plan
January 1, 1990	EPA to begin enforcement compliance

APPENDIX B

TOBACCO/TOBACCO PRODUCTS

1. **Description:**

A lighted cigarette gives off about 4,000 compounds which can be separated into gas and particulate phases. Carbon monoxide, nicotine and tar have been identified as the most likely chemicals affecting a person's health.

According to the most recent reports from the Surgeon General on Smoking and Health, nicotine is principally responsible for cigarette smokers' physiological responses including increased heart rate, blood pressure, cardiac output, smoke volume, oxygen consumption, coronary blood flow, and aerenchyma bronchoconstruction and related pulmonary effects, increased artuitary and utilization of free fatty acids, and hyperglycemic effects also are a result of the use of tobacco products.

2. **Source:**

Tobacco is a leafy plant, nicotine tobacum, which contains the psychoactive drug nicotine. The three routes of ingesting tobacco are smoking (inhalation), chewing (oral), and snuffing (membrane absorption).

3. **Health Effects:**

The health effects of smoking tobacco are correlated to the drug and the method of administration. Cigarette smoking has been causally related to various types of cancer, cardiovascular diseases, emphysema, gum infections and burns.

Smoking and other physical and chemical agents in the working environment may interact to produce an increase in health effects. Smoking products may serve as vehicles for other toxin agents, thereby facilitating entry into the body by other agents.

4. **Law/Regulations:**

It is against the law to sell cigarettes to persons sixteen years old and younger.

See the Anne Arundel County Public School's Policy 9-37, Use of Tobacco and Tobacco Products at end of this appendix.

5. **Notification:**

None

6. **Measurements:**

None

7. **Standards/Guidelines:**

A. *Staff* - Smoking in designated areas only. Designated areas to be ventilated if resources allow. Selection of area to have as a major consideration is its separation/isolation from the student population. All new construction or major renovation of existing schools will have designed into the designated areas adequate ventilation and student separation.

B. *Students* - See the Anne Arundel County Public School's Policy 9-37, Use of Tobacco and Tobacco Products at the end of this appendix.

8. Control Methods:

A. Inspection of existing ventilation systems in areas where smoking is permitted to insure its adequacy. Where adequate ventilation cannot be provided, schools are encouraged to provide local "smoke-areas" to provide near term relief for non-smokers.

B. Terminating smoking accessibility.

9. For Further Information:

- American Lung Association
- American Cancer Society
- Health Issues Office, Anne Arundel County Public Schools
- Center for Disease Control, Atlanta

APPENDIX B

ATUP

ANTI-TOBACCO USE PROGRAM

(Effective 1/30/89)

Administrative Regulation
9-37, Use of Tobacco and Tobacco Products

FIRST OFFENSE

A student who violates the policy for the first time must attend the Anti-Tobacco Use Program (ATUP).

Administrative Action:

1. A student shall meet with a school administrator, shall be reminded of the provisions embodied in Board Policy 9-37, and shall be enrolled in the school system's Anti-Tobacco Use Program (ATUP).
2. SAMPLE LETTER 1 - **FIRST OFFENSE** - ATUP Enrollment shall be signed by the pupil and sent home to the parents or guardian(s). Copies will be sent to:
   - A. ATUP Coordinator
   - B. File

A student who fails to attend and complete the ATUP will be suspended from school and a request will be made to the Superintendent of Schools for an expulsion from school.

ATUP Coordinator Action:

1. The ATUP Coordinator will contact the parent(s) or guardian(s) with enrollment information concerning the Anti-Tobacco Use Program (ATUP). The information will include:
   - A. Dates of the class
   - B. Times of the class
   - C. Location of the class

Pupil Services Action:

1. The pupil personnel worker will process the principal's request for expulsion if the student fails to attend and complete the ATUP.

SECOND OFFENSE

A student who violates the policy for the second time will be suspended from school for up to five school days and shall be referred to the Division of Pupil Services.

Administrative Action:

1. SAMPLE LETTER 2 - SECOND OFFENSE - Shall result in a suspension of up to five school days and a referral to the Division of Pupil Services.

Pupil Services Action:

1. A conference shall be held with the pupil personnel worker in conjunction with a school administrator.
2. In order to be readmitted to school, the student and his parent(s) or guardian(s) will sign a Use of Tobacco Reinstatement Form.
3. The pupil personnel worker will recommend that the student enroll and complete a recognized out-of-school Anti-Tobacco Use counseling/treatment program. Written information concerning these programs will be provided to the student and his parent(s) or guardian(s).
4. The student will be afforded the opportunity to voluntarily enroll in the school system's Anti-Tobacco Use Program.

THIRD OFFENSE

A student who violates the policy for a third time shall be suspended from school for five school days and a request will be made to the Superintendent of Schools for an expulsion from school.

Administrative Action:

1. SAMPLE LETTER 4 - THIRD OFFENSE - Shall result in a suspension of five school days and a request will be made to the Superintendent of Schools for an expulsion from school.
2. Third violation offenses must be referred to the Office of the Special Assistant to the Superintendent of Schools for investigation.

Special Assistant Action:

1. A conference will be held with the student and his parent(s) or guardian(s).
2. All aspects of the expulsion process and appeal rights will be carefully and succinctly explained to the student and his parent(s) or guardian(s).

ANNE ARUNDEL COUNTY BOARD OF EDUCATION

9-37
Adm. Reg.

STUDENTS

STUDENT CONDUCT

9-37 Use of Tobacco and Tobacco Products

A. Use of Tobacco

1. Purpose:

The purpose of these regulations is to provide procedures for administering the provision of Board of Education Policy 9-37 Use of Tobacco and Tobacco Products.

2. Use of Tobacco

a. The use of tobacco by students on school property or at school-sponsored activities during the regular school day is prohibited.

b. The use of tobacco by students in school buildings at after-school, evening, or weekend activities is prohibited.

c. The use of tobacco by students on school-sponsored field trips is prohibited.

3. Definitions - as used in these regulations, the following terms have the meanings indicated:

a. School property - means any property, vehicle, building, grounds, or item leased to, under the jurisdiction of, or owned by the Board of Education of Anne Arundel County.

b. Regular school day - means from the time a student boards a school bus to go to school until a student leaves the bus after attending school. For students who do not ride a school bus, the regular school day begins when a student arrives on school property and ends when the student leaves school property.

c. Field trip - means any organized class or extra-curricular activity involving students sponsored by, supervised by, approved by, or otherwise under the jurisdiction of the Board of Education of Anne Arundel County or its agents or representatives. Field trips may or may not involve school property and may take place during or outside of the regular day.

4. School Action:

When it has been established to a Principal's satisfaction that a student has violated Board of Education Policy 9-37, Use of Tobacco and Tobacco Products, a Principal will take the following actions:

ANNE ARUNDEL COUNTY BOARD OF EDUCATION

STUDENTS

STUDENT CONDUCT

9-37 Use of Tobacco and Tobacco Products

A. Use of Tobacco (Continued)

a. First Offense - ATUP Enrollment. A student who violates Board of Education Policy 9-37, Use of Tobacco and Tobacco Products, shall meet with a school administrator, shall be reminded of the provisions embodied in Board Policy 9-37, and shall be enrolled in the Anti-Tobacco Use Program (ATUP).

A copy of the first offense letter will be sent to the student's parent(s) or guardian(s) notifying them of the dates, time and place for the ATUP. A copy will be placed in the student's cumulative record file.

b. Second Offense - A second violation of Board of Education Policy 9-37, Use of Tobacco and Tobacco Products, shall result in a suspension of up to five school days and a referral to the Division of Pupil Services.

To be re-admitted to school, the student and his parent(s) or guardian(s) shall sign a Use of Tobacco Reinstatement Form.

c. Third Offense - A third violation of Board of Education Policy 9-37, Use of Tobacco and Tobacco Products, shall result in a suspension of five school days, and a request to the Superintendent of Schools for an expulsion from school.

5. Consideration for Readmission to School

A student, his parent or guardian must write the Superintendent of Schools requesting a conference to review the expulsion. Consideration for readmission to school will include:

a. Evidence of student's participation in an out-of-school recognized program of Anti-Tobacco Use counseling/treatment.

b. Consideration of the nature and severity of the incident leading to expulsion.

STUDENT CONDUCT

9-37 Use of Tobacco and Tobacco Products

A. Use of Tobacco

5. Consideration for Readmission to School (Continued):

c. A review and evaluation of student's school record including consideration of attendance, academic performance, and behavior.

Decisions regarding readmission to school will be determined on a case by case basis. Generally, it will be expected that:

- The student has been separated from the public school system for one full semester or for 18 weeks of school.

This procedure may be modified by the aggravating or mitigating circumstances of a particular case.

RADON

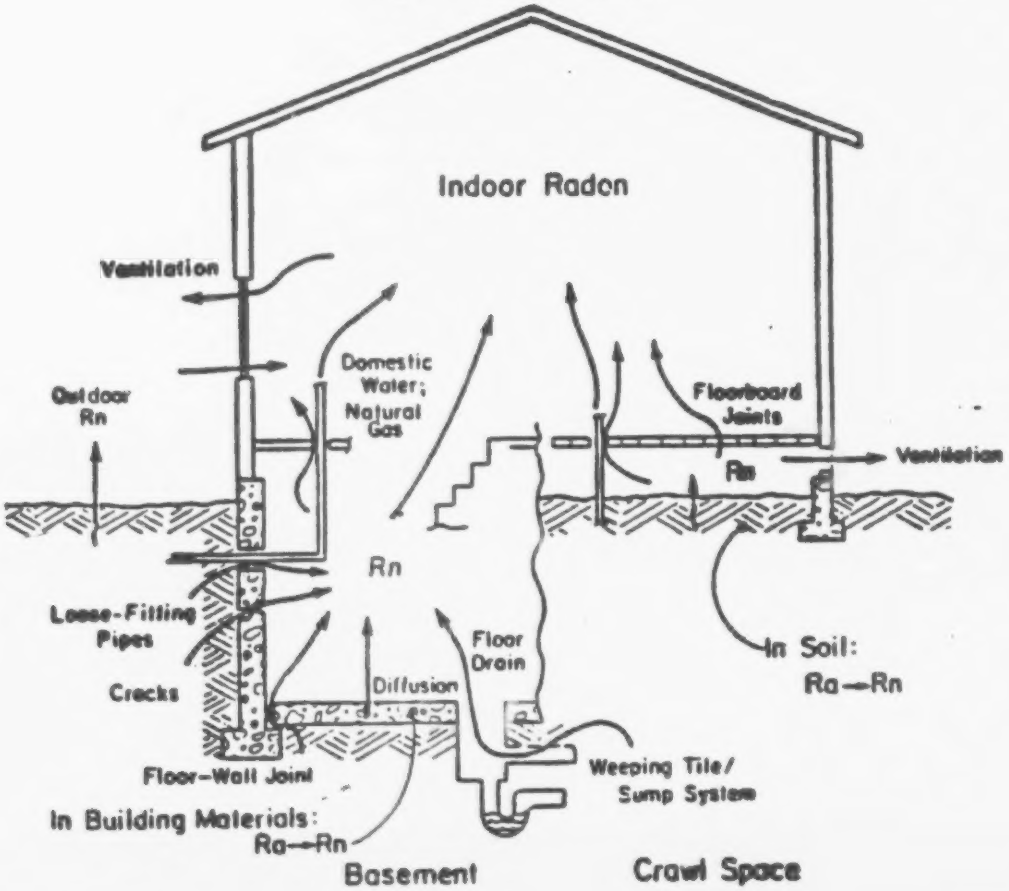
1. Description:

Radon-222 is a radioactive, colorless, odorless and tasteless gas that occurs naturally in the earth's crust. It is formed when Radium-226 decays. Because it is a gas, radon diffuses to the earth's surface through cracks, voids and fissures, either entering the ambient air and quickly dissipating to safe levels, or entering a building and possibly concentrating into unsafe exposure levels. Because radon is radioactive, it further decays into nongaseous radioactive products. The Surgeon General's office and the EPA have advised that continued human exposure to high levels of radon can cause lung cancer. They estimate that up to 20,000 lung cancer deaths a year may be radon related.

2. Sources:

Radon can enter a building by way of its water system, off-gassing of building materials, or from the building's subsoil through cracks, voids or other openings in the foundation. The last of these methods of entry currently is considered the most common. Figure C-1 is a graphic illustration of the numerous routes radon may take as it migrates into a facility.

Figure C-1. Indoor Radon


Indoor Radon
Ventilation
Outdoor Rn
Domestic Water; Natural Gas
Floorboard Joints
Rn
Ventilation
Rn
Loose-Fitting Pipes
Cracks
Diffusion
Floor Drain
In Soil: Ra→Rn
Floor-Wall Joint
Weeping Tile/ Sump System
In Building Materials: Ra→Rn
Basement
Crawl Space

3. Health Effects:

The risk of radon and its decay within the human lung is that of elevating the incidence of lung cancer among building occupants. Studies of the mortality of miners chronically exposed to elevated concentrations of radon have shown such increased incidence. The EPA has recommended 4 picocuries per liter (pCi/1) as an action level for both the home and schools. Even at this level, exposure to radon and associated radon decay products increase the lifetime risk of acquiring lung cancer by 2 per 100. Some research shows that smoking in combination with high radon levels may be ten times more harmful than exposure to either by itself.

4. Laws and Regulations:

On March 14, 1989, EPA released *An Interim Report* on Radon Measurements In Schools. It is the most authoritative document available. Its protocols **will** be followed for all testing done in AACPS facilities. A copy of this report is in Volume II for reference by any interested party. A summary of its findings and recommendations as they pertain to schools follows.

a. Effect on Schools -
- Concentrations typically vary from room to room.
- Schools in the same general area can have significantly different radon concentrations.
- Concentrations within any school will vary over time.
- Radon levels are generally higher in basement and first floor rooms than on upper-level floors.

b. Radon Measurement in Schools (EPA recommendations) -
- Test all frequently occupied rooms in the basement and ground level floor(s).
- For open space schools, test every 2,000 square feet.
- If resources are constrained, test the most likely contaminated space such as:
  - = Basement classrooms.
  - = Rooms isolated from central HVAC system.
  - = Rooms on or near structural joints or the end of wings.
  - = Rooms with floor slabs having many cracks.

c. Time of Year - Test during cooler months (October through March) when windows and doors will be closed and the heating system is in operation.

d. Types of Measurements -
- Screening tests to determine the extent of any potential radon contamination problem. This phase is usually accomplished using either the **charcoal canister** or the newer **electret ion chamber** technology. The same basic protocol may be used for these two methods.
- The results of the screening tests may require confirmatory measurement(s) be taken. This phase should use **alpha track** or **electret ion chamber** technology. Again, the same basic protocol may be used for either method.

5. Measurement:

The three testing methods (charcoal canisters, alpha track detectors, and electret ion chambers) are further described on page 86.

6. Notification:

The school administrator and the AACPS' Health Issues Coordinator will be notified when it has been determined that potential radon contamination of a school building exists. At this time, a detailed plan to validate and analyze the extent of the problem will be provided. This information will be shared with the parents through the PTA, citizens advisory committee (CAC) or other means as deemed appropriate by the school administrator.

7. **Standards/Guidelines:**

In their Interim Report, EPA has set 4 pCi/L as the safe school radon test concentration level. Readings above this point will require further analysis/measuring to determine corrective action needed.

8. **Equipment Requirements:**

Beyond the equipment required to test for radon (see below), few other items are needed. At this time, no protective clothing or equipment is required.

Charcoal canisters should be bought in bulk, including readout services, to realize the associated cost savings. **Alpha track detectors** should be purchased on an as-needed basis. **Electret ion chambers** are reusable indefinitely with only their electrets requiring periodic replacement, the exact number of which depends on the radon concentration. Air sampling **continuous monitors** are expensive ($1,500). They should be leased or jointly procured with other districts if possible.

Irrespective of the test method used, an effective record keeping system for data is vital to analysis and effectiveness of a radon program!

9. **Methods of Control:**

New Construction - There is no known cost-effective way to survey a school site to determine the long-term potential for radon contamination. Additionally, topography often dictates the placement of buildings. The best that can be done is to consider design features that would impede radon entry or facilitate radon gas removal. For example, radon gas could be removed, if necessary, through special design adaptation of the foundation sub-surface drainage system.

Renovation - Sealing of cracks and joints in existing foundation and concrete slabs is a must. The potential for subslab ventilation also should be considered. Placement of a barrier that intercepts and diverts the gas may be an option. In addition, drain fields placed around the footers of many schools during construction may be an excellent collection point to vent radon gas before it enters the building.

10. **For Further Information:**

- Maryland Department of the Environment, Center for Radiological Health - (301) 631-3300
- AACPS - Operations Division - (301) 647-7470
- AACPS - Maintenance Division - (301) 255-2535
- Anne Arundel County Health Department - (301) 224-7360
- Environmental Protection Agency - Hotline (24 hours) - (202) 544-1404

APPENDIX C

METHODS OF TESTING

FEATURE	CHARCOAL CANISTERS	ALPHA TRACK DETECTORS	ELECTRET ION CHAMBERS
Range of Measurement	Short-Term Screening 1 to 3 days	Long-Term Confirmatory Measurement 30 days to 1 year	Short-Term Screening, Long Term Diagnostic and Long-Term Confirmatory Measurement 1 day to 1 year
Price Range	$10-$30 each	$25-$50 each	$3 - $30 each
Exposure Time	24-48 hours	30 days plus	24 hrs. to 365 days
Strength	Fast, inexpensive way to determine if a school has a radon problem.	Accurate way to measure long-term radon levels.	Accurate, flexible system, not affected by humidity. Digital read-out on site allows for immediate readings of radon levels. Repeat measurements possible with same detectors.
Weakness	Represents a snapshot in time while canister is open. Does not allow for variations in radon intensity over time or across the building space. Must be sent to a laboratory for results.	Time-consuming before results. Must be sent to a laboratory for results.	Registers gamma radiation background which can be deducted from the measured result. Requires EPA acceptance of the "reader" if results are to be determined by in-house work force.
Recommended Use	Sampling to determine if a problem exists. Augment with use of alpha track before mitigation is considered. Quick response situations under public pressure/concern.	In-depth study of a problem. Advised before mitigation is taken.	Offers same features of the other two test methods. Additionally, allows screening of buildings, mapping of rooms for diagnosis of points of entry, measurement of intermediate and long-term radon concentration and variation with weather or seasons. Measurement of actual radon exposure during occupancy.

Protocols for testing with **charcoal canisters** or **alpha track detectors** are found in the Appendices of the EPA's Interim Report (Volume II). These same protocols can be used for the **electret ion chamber**.

FORMALDEHYDE

1. Description:

Formaldehyde is a chemical used in the production of a wide variety of products that may be introduced into building during initial construction or renovation. Formaldehyde is a gas. Thus, its route of exposure is inhalation. It is also an irritant to the eyes and respiratory tract. The threshold of smell is often listed at 1 part per million (ppm), but some individuals have been reported to sense it as low as 0.05 ppm. Formaldehyde is considered a probable human carcinogen.

2. Sources:

Formaldehyde is used in many building products. For example, formaldehyde is used in the manufacture of a variety of resins, which are then used for adhesives and binders for such materials as plywood, particle board and insulation. The textile industry uses formaldehyde products to add properties such as flame-resistance and shrinkage reduction.

Products that may be potential sources of formaldehyde are wallboard, paneling, furniture, shelves, partitions, draperies, wall coverings, upholstery, carpeting, and ceiling tiles. After these products are manufactured, formaldehyde gas may be released for weeks or months. Therefore, formaldehyde is often present after construction or renovation.

Another source in schools may be in chemistry or biology laboratories. Formalin is a solution of formaldehyde gas in water, usually with methyl alcohol added as a stabilizer. Formaldehyde is also present in tobacco smoke and some combustion products.

3. Standards:

A. OSHA (MOSH) - 29 CFR 1910.1048; Adopted in 1988
    1. PEL - 1 ppm (Action Level 0.5 ppm)
    2. Many requirements for occupational exposures, including:
        a) Initial Monitoring
        b) Housekeeping (spills) Procedure
        c) Training

B. HUD - 24 CFR 3280
    1. Applies to Mobile Homes
    2. Standard sets Emission Rates

C. AIHA Community Air Quality Guideline
    1. Short Term Exposure Level (30 mins.)
    2. Exposure Level - 120 ug/m^3

D. ASHRAE Selected Guidelines for Air Contaminants of Indoor Origin
    1. Continuous
    2. Exposure Level - 120 ug/m^3

E. ACGIH
    1. TLV - 1 ppm (1.5 mg/m^3)
    2. STEL - 2 ppm (15 mins.)
    3. Notation - Suspect Human Carcinogen

4. Notification:
None

5. How to Inventory/Survey:
Because of its presence in building products, complaints of formaldehyde exposure symptoms frequently follow new construction or renovation. Depending on the type of ventilation system, the complaints could be localized or widespread. The renovation may be obvious, such as new carpeting or furniture, or less obvious, such as replacement of stained or damaged ceiling tiles, or new built-in closet shelves made of chip board (see Section 8 - Remedial Actions).

6. Acceptable Levels:
Section 3 covers enforceable and recommended levels. Due to formaldehyde's irritating properties, it should be maintained at as low a level as possible.

7. Equipment (monitoring):
The most common method of monitoring employs detector tubes. These allow measurement in the range of 0.2 - 5.0 ppm, depending on the manufacturer. Detector tube readings can normally be made in one to several minutes.

Longer period samples can be obtained through the use of dosimeter tubes or badges. Similar in concept to detector tubes, they can be left exposed for longer periods of time (typically, one to eight hours).

The above methods work on a color change principle. They can be read immediately, and are relatively cheap and easy to use. Disadvantages include a relatively low degree of accuracy; other gases may interfere and produce higher or lower readings.

More accurate means of monitoring exist, but these involve a laboratory analysis and the local authority would be advised to utilize a consultant for the use of these methods.

8. Remedial Action
Because irritation from formaldehyde commonly follows construction or renovation, a pro-active approach, rather than a remedial approach, is recommended. The following suggestions for some types of products illustrate actions that will result in lower exposures immediately after the installation of materials or products. To the extent possible, the activities should take place before the products are brought into the building.

Carpeting may be pretreated by heating or steaming, to accelerate off-gassing prior to installation. Laminated products (shelves, etc.) should have all surfaces (i.e., ends of shelves, unexposed surfaces) covered with laminate. Furniture, shelf units, etc., often are shipped broken down, with pre-drilled holes for assembly. All pre-drilled holes should contain removable plugs, and any unused holes should remain plugged after assembly.

The above suggestions are examples of controls that some manufacturers are taking to make their products more marketable to a public more cognizant of formaldehyde hazards. Prior contact with manufacturers or dealers may result in other steps that can be taken, so that new products or materials will produce minimum exposure levels, after installation.

If the above cannot be accomplished, it is recommended that installations be made with as long a lead time as possible prior to occupancy. Subsequent to installation of products that may off-gas formaldehyde, it is recommended that the air be circulated at as high a rate as possible, with outside air (as opposed to recirculated air) being supplied at maximum amounts. A separate exhaust to the exterior may be employed, during this period, and if possible, the interior return air system (recirculated air) should be blocked off.

The above steps are probably most feasible during new construction. For renovation, furniture, draperies, carpeting, etc., may be stored, with protective coverings removed, in a warehouse (with maximum ventilation) to promote initial off-gassing prior to installation. For smaller jobs (often done on Fridays, prior to a weekend with the ventilation turned off), maximum ventilation should be provided subsequent to and during the work. If possible, specify low formaldehyde emitting products.

If low level formaldehyde emissions are suspected in buildings (as with most other indoor air contaminants), it is recommended that the ventilation system be checked and adjusted to meet ASHRAE recommendations if required.

9. For Further Information:

- MOSH Public Sector Consultation, 333-4135 (1-800-492-6226, extension 4135)
- Maryland Department of the Environment (301) 631-3834

VOLATILE ORGANIC COMPOUNDS (VOCs)

1. Description:

A volatile organic compound (VOC) is any organic compound that exists as a gas or easily off-gases at room temperature. Nearly all organics which can be considered VOC have vapor pressures greater than 0.1 mm Hg at 20oC and 760 mm Hg.

2. Sources:

The primary sources are personal hygiene and cosmetic products, building materials, cleaning products, disinfectants, art and industrial arts materials, molded plastic containers, refrigerants, aerosol propellants, gasoline, carbonless paper, photocopying materials, and paints. There are hundreds of volatile organic compounds that are found in the indoor air. Those listed below do not comprise a complete list.

acetone - by-products of human metabolism, cleaners, personal care products, tobacco smoke
acrolein - tobacco smoke
alcohols - by-products of human metabolism, cleaners, personal care products, tobacco smoke
ammonia - cleaners, tobacco smoke
aromatic hydrocarbons - combustion processes, pesticides, paints, solvents, tobacco smoke
benzene - combustion processes, gasoline, solvents, tobacco smoke
chlorinated hydrocarbons - wood preservatives, PCBs, solvents
organophosphates - pesticides
phenols - equipment, furnishings, tobacco smoke
toluene - adhesives, gasoline, paints, solvents, tobacco smoke

3. Health Effects:

The health effects of indoor non-occupational exposures to VOCs are not yet well understood. The large number of chemicals found indoors makes it extremely difficult to associate health effects with exposures to specific compounds.

Various compounds found indoors have been associated with headache; irritation of eyes, mucous membranes, and respiratory system; drowsiness; fatigue, and general malaise. Occupational exposure studies have documented health effects from some VOCs, including cancer, mutagenicity, respiratory ailments, heart disease, allergic reactions, and other toxic effects. Research is also underway to characterize any health effects associated with combinations of VOCs.

4. Laws/Regulations:

None

5. Notification:

Under the Right to Know Law, information must be available to employees about chemicals they may use or may be exposed to in the workplace.

6. Measurement:

Gas chromatographs and portable photoionization meters are used for laboratory and field studies to measure VOC concentrations. Inexpensive monitors suitable for extensive field use exist; however, their results are not reliable.

7. Standards/Guidelines:

No standards have been set for VOCs in non-industrial settings. NIOSH and ACGIH have recommended occupational standards for many compounds. ASHRAE Standard 62-1981R includes a rationale suggesting that in the absence of better data, the NIOSH limits should be divided by 10, to account for possible continuous exposure, and to account for the elderly, young, and infirm in the general population. ACGIH is developing recommended standards for indoor air contaminants.

8. Control Methods:

Construction, maintenance and operation materials should be selected to avoid or minimize VOC emissions. Where practical, uses of these sources should be restricted, and these materials should be stored in well-ventilated areas away from occupied zones. Direct exhaust will be required for specific activities; e.g., spray-painting, glueing, science experiments.

9. For Further Information:

- Maryland Department of the Environment,
  Center for Special Toxics (301) 631-3300
- Anne Arundel County Health Department (301) 224-7360

CARBON MONOXIDE

1. **Description:**

CO is a colorless, odorless, and tasteless gas. It results from incomplete oxidation of carbon in combustion.

2. **Sources:**

Incomplete oxidation during combustion in gas ranges, unvented heaters, leaky wood and coal stoves, and tobacco smoke may cause high concentrations of CO in indoor air. Worn or poorly adjusted and maintained combustion devices can be significant sources. Automobile, bus, or truck exhaust entering buildings from attached garages, nearby roadways, or parking areas can also be a source of CO.

3. **Health Effects:**

Carbon monoxide poisoning is entirely by inhalation. The most common symptoms are pounding of the heart, dull headache, flashes before the eyes, dizziness, ringing in the ears, and nausea. Where poisoning is severe enough to cause unconsciousness, damage to the brain, central nervous system, and circulation may occur. Symptoms are increased in the very young and in persons with heart disease, anemia, asthma, or hypermetabolic diseases. Short-term exposures to high levels of carbon monoxide can be fatal.

4. **Laws/Regulations:**

None

5. **Notification:**

Report to MOSH is required for any employee injury resulting from exposure to carbon monoxide.

6. **Measurement:**

Some relatively high-cost infrared-radiation absorption and electrochemical instruments do exist. Moderately priced real-time measuring devices are also available.

7. **Standards/Guidelines:**

50 parts per million (ppm) in an eight-hour period is the standard for employees under MOSH guidlines. The U.S. National Ambient Air Quality Standard is 40 micrograms per cubic meter (mg/m3) for a one-hour period.

8. **Control Methods:**

It is most important to be sure combustion equipment is maintained and properly adjusted. Vehicular use should be carefully managed when adjacent to buildings and in vocational programs. Additional ventilation can be used as a temporary measure when high levels of CO are expected for short periods for time.

9. **For Further Information:**

- Maryland Department of the Environmental,
  Center for Special Toxics (301) 631-3300
- Anne Arundel County Health Department (301) 224-7360

CARBON DIOXIDE

1. **Description:**

CO_2 is an odorless, tasteless, and colorless product of complete carbon combustion.

2. **Sources:**

All combustion processes and the human metabolic processes are CO_2 sources. Concentrations of CO_2 from people and smoking are always present in all occupied buildings, typically at levels well below 1000 ppm.

3. **Health Effects:**

With extreme exposures to carbon dioxide (above 10,000 ppm), some loss of mental acuity and fatigue can be experienced. Carbon dioxide is used as a surrogate of other IAQ problems (e.g., poor ventilation).

4. **Laws/Regulations:**

None

5. **Notification:**

None

6. **Measurement:**

Reliable and inexpensive instruments exist for use in most commercial settings. Measurements should be made during periods of normal occupancy.

7. **Standards/Guidelines:**

ASHRAE Standard 62-1981 sets 2,500 ppm as an upper limit but proposes 1,000 ppm as a surrogate for other pollutants. The outdoor level is usually 300 ppm. Indoor concentrations are usually in the range of 500 to 1,000 ppm.

8. **Control Methods:**

Ventilation methods are used to control carbon dioxide.

9. **For Further Information:**

- Maryland Department of Environment,
  Center for Special Toxics (301) 631-3300
- Anne Arundel County Health Department (301) 224-7360

BIO-AEROSOLS

1. Description:

Bio-aerosols or airborne biological agents include bacteria, fungi (yeasts and mold), pollen, dander, and insect parts. These particulates range from less than one micron to several microns in size. When airborne, they are usually attached to dust particles of various sizes so that all sizes of airborne particles may include them.

Generally, airborne viable (living) organisms may be categorized into the following groups:

Fungi

- Actinomycetes - fungus-like bacteria which includes Actinomycetes and yeasts.
- Eumycetes - (true fungi) such as Penicillium and Aspergillus

Bacteria

- Thermophiles - bacteria, such as Streptococcus faecalis, which grow optimally in the range of 40-70°C.
- Mesophiles - bacteria which grow best at body temperature (37°C), including Klebsiella, Pseudomonas, Salmonella, E - coli, Proteus, and Shigella.
- Micro-aerophiles - bacteria such as alpha and beta-Streptococci which thrive in low oxygen environments.
- Saprophytes - bacteria, such as Staphylococcus epidermidis, which are naturally associated with decaying matter.

Other microorganisms which have been implicated as etiologic agents for building-associated illnesses include water-borne organisms, such as the bacteria Legionella and various protozoan species.

The microorganisms responsible for normal childhood diseases such as measles, mumps and chickenpox will not be considered in this document.

Non-viable (non-living) biological agents have also been implicated as etiologic agents. This group would include animal dander, pollen and insect parts.

2. Sources:

In many cases, biological agents enter buildings through fresh air intakes, and due to their small size, are not effectively eliminated from the air stream by ordinary building air filtration systems. Once the agents have settled out of the air stream, viable spores and bacteria may incubate and grow almost anywhere in a building where conditions permit. These conditions include:

- a surface for growth
- organic nutrients on the surface
- darkness
- moisture and/or greater than 70 percent relative humidity.

These conditions are frequently encountered in building air handling system ductwork. Fiberglass insulation, when mounted inside air handling units and ductwork, provides a vast surface area for mold growth while protecting it from the air stream. Darkness and organic dust deposits are inherent in ducts. Due to rapid fluctuations in temperature and relative humidity, condensate moisture is sometimes present in ductwork. High relative humidity in office spaces can result from roof leaks, building floods, and air handling system design, engineering and maintenance deficiencies.

Other building components offering suitable growing conditions include: cooling towers, humidifiers, dehumidifiers, drip pans and cooling coils of air handling units, water-damaged materials such as ceiling tile, insulation and carpet, other porous surfaces, and in general, poorly maintained areas.

Biological agents can be carried indoors by people and distributed indoors by "shedding." Also, pets, insects and plants represent potential sources of etiologic agents.

3. Health Effects:

Building-related complaints include diverse symptoms and conditions which have different etiologies. The majority of complaints related to "sick building syndrome" include mucous membrane irritation, headache, odors, perception of stale air or stuffiness, and fatigue. These can be caused by a number of indoor air contaminants present in low levels including tobacco smoke, carbon monoxide and chemical vapors, possibly due to inadequate ventilation. Usually, a large number of occupants are affected. "Sick building syndrome" can frequently be corrected by attention to the ventilation system, including its design, operation and maintenance. Biological agents would not be suspected for "sick building syndrome" complaints.

Building-related diseases are comprised of infectious diseases (such as legionellosis) and hypersensitivity diseases. The hyper- sensitivity diseases, caused by individual immunologic sensitization to bio-aerosols, include humidifier fever and hypersensitivity pneumonitis, asthma and allergic rhinitis, i.e. inflammation of nasal mucous membranes due to sensitivity to an allergen.

For example, when mold proliferation remains unchecked for a long period of time, spores are released into the air stream in large quantities during the mold's reproductive cycle. These spores constitute an allergenic challenge to the immune systems of people who are exposed. Depending on the spore concentration and room ventilation, these spores can evoke allergic symptoms in susceptible individuals.

Building occupants who are exposed to sporadic bursts of highly concentrated mold spore allergens or moderately elevated but sustained levels over a period of months or years are at risk of becoming sensitive to these recurring allergens. The condition of sensitization arises when an individual's immune system, after repeated exposure to specific allergens, learns to recognize and react to the allergens more easily and with greater intensity than the immune system of someone who has not been frequently exposed. Consequently, the sensitized person who has been in an area for some time may react to relatively low concentrations of allergens while a new occupant in the same space may exhibit few or no allergic symptoms.

Humidifier fever and hypersensitivity pneumonitis are systemic illnesses. Humidifier fever is characterized by fever, chills, muscle aches, and malaise without prominent pulmonary symptoms and signs.

Hyper-sensitivity pneumonitis is characterized by acute recurrent pneumonias with fever, cough, chest tightness, and lung infiltrates, or by progression of cough, shortness of breath, and fatigue, or an intermediate pattern of acute and chronic lung disease. The diagnosis of hyper-sensitivity pneumonitis is made by a physician on the basis of the individual's history and some of the following: restrictive pulmonary function tests; a pattern of exercise tolerance test findings that are compatible with interstitial lung disease, granulomas and interstitial fibrosis in a lung biopsy; bronchial challenge with sterile extracts of implicated environmental organisms, and response to corticosteroid medications.

Hyper-sensitivity pneumonitis is among the most serious of the building-related illnesses. Since its occurrence requires individual sensitization to a specific bio-aerosol, one case may constitute an outbreak requiring investigation and remedial action. In an individual case, exposure to bio-aerosols in settings other than the building must be considered.

The other hypersensitivity disorders, asthma and allergic rhinitis, are less clearly documented by the medical literature to be associated with bio-aerosols in building environments. However, individual cases require the inclusion of these diseases as building-related or building-exacerbated illnesses. Asthma presents complaints of chest tightness, wheezing, cough, and shortness of breath, and rhinitis includes symptoms of runny nose, nasal congestion, and sneezing. Symptoms may occur within an hour of exposure to a bio-aerosol or may be delayed for 6 to 12 hours or both. However, a pattern of exacerbation will usually be present when the issue of building aerosols is raised, since these conditions are common in the general population. Again, physician diagnosis of these diseases is required. For asthma, physicians rely on the history of the individual, wheezing during physical examination, reversible air flow limitation on pulmonary function tests, and elicitation of air flow limitation when low doses of methacholine or histamine are introduced. Allergic rhinitis is diagnosed based on the medical history of the individual, and by physical examination, eosinophils on a nasal smear, and (in scientific investigation) specific nasal challenge.

For building-related illnesses, physician collaboration is critical in making a diagnosis and suggesting etiology. Epidemiologic consultation may also be required. Epidemiologists can assist in establishing whether there is a problem, the nature of the illness, and an hypothesis regarding the source of the contaminant. The tools of epidemiology are to establish a case definition, to systematically search for cases using screening tests, and to analyze these cases by their occurrence in time, place and person. A control group may be necessary, depending on the specificity of the symptoms or disease and the expected prevalence of the condition in the population. As mentioned above, however, one case of hypersensitivity pneumonitis, which is a rare and serious disease, may require investigation in order to prevent possible sensitization of others.[7]

4. **Laws and Regulations:**
   None exist at the writing of this document.

5. **Notification and Reporting:**
   None required.

6. **Measurement:**
   Bio-aerosol sampling should be undertaken only in cases where positive evidence exists for diseases related to biologic humidifier fever, hypersensitivity pneumonitis, allergic asthma, and allergic rhinitis. For complaints in other organ systems; e.g., skin, reproductive system, no evidence exists to support microbial aerosols as etiologies.

When hypersensitivity disorders of possible building-related infectious disease (such as legionellosis) exist, a walkthrough inspection of the indoor environment is recommended. The occupied space should be examined for potential sources of biological aerosols such as damp organic material and porous wet surfaces. Potential reservoirs and amplification sites for microorganisms should be examined, especially in the HVAC (heating, ventilation, air conditioning) system. Examples of other presumptive sources appear in Table G-1. If such presumptive sources are present, remedial actions may be quite straight forward, occupant problems may be resolved, and further complicated sampling procedures may be unnecessary. For example, humidifiers containing reservoirs of stagnant water are commonly contaminated with microorganisms. Fastidious cleaning of humidifier components, frequent replacement of reservoir water, and better filtration of air entering the humidifier may reduce potential contamination.[8]

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[7] ACGIH Bio-Aerosol Committee, "Guidelines for Assessment and Sampling of Saprophytic Bio-aerosols in the Indoor Environment," Applied Industrial Hygiene, September 1987.

[8] Burge, Harriet, "Sample Analysis and Data Analysis," University of Michigan Conference; Assessing Bio-aerosol Hazards in the Workplace, September 1987.

Table G-1
Presumptive sources of bio-aerosols in the indoor environment

	Source	Nature of Contamination
1.	Cooling coil section of air handling unit	•Amplification of microorganisms may occur on wetted surfaces of coiling coils and in drain pans.
2.	Humidifier containing reservoirs of stagnant water	•Organic dusts and debris are scrubbed from the air stream; microorganisms may amplify in water reservoir and on wetted surfaces of device.
3.	Steam humidifier	•Condensed water from improperly trapped devices may serve as a niche for amplification of microorganisms.
4.	Air washer; water spray system in air handling unit	•Microorganisms grow on wetted mechanical surfaces, in water reservoirs, and on porous substrates associated with these devices; see comments for 1 and 2.
5.	Fan coil units; induction units	•These devices may serve as reservoirs for microbial contaminants; check for accumulated dust and debris; see 1 for comments.
6.	Filters in air handling and fan coil units	•Where maintenance is poor, filters may function as reservoirs for microbial contaminants; amplification can occur if humidity is excessive or if filter is wet.
7.	Porous man-made insulation in ventilation system	•Dirt and debris are trapped in porous areas; can become microbial reservoir; if insulation is wet microbial amplification can occur.Dirt and debris are trapped in porous areas; can become microbial reservoir; if insulation is wet microbial amplification can occur.
9.	Outdoor Air	•Outdoor bio-aerosols are the ultimate source of most indoor contamination.
10.	Porous man-made insulation in ventilation system.	•Ceiling tiles, carpet especially with natural fiber padding, wicker furniture, upholstery, etc., may function as microbial amplification sites.
11.	Relative humidity greater than 70% in indoor environment	•The equilibrium moisture content in organic dusts and substrates may rise to the point where it may support the amplification of microorganisms.

The walk-through inspection should include occupant interviews which are helpful to establish a history of the occupant complaints. Common questions helpful to the investigator have been summarized in Table G-2. Also a detailed questionnaire such as Example 1 in Volume II of this document can aid in identifying sample locations and determine if occupants are experiencing hypersensitivity diseases and not sick building syndrome.

Table G-2
Questions to Ask Building Occupants[9]

1. What symptoms have you experienced at your work area? (Headache, muscular ache, backache, neckache, chest pain or tightness, eye irritation, throat irritation, nose irritation, nausea, flu symptoms, shortness of breath, weakness, depression, sleepiness, dizziness, fatigue, fever, nervousness, difficulty concentrating, skin dryness, skin rash or itching, trouble focusing eyes, etc.)
2. When did you first notice such symptoms?
3. Is there any event associated with the initial onset of the symptoms? (Building renovations, new carpeting, new paint, new equipment, etc.)
4. How often do the symptoms occur? (Number of times per day, per week, or per month, etc.)
5. How long do the symptoms last? (All week, all day, several hours, several minutes, come and go intermittently, etc.)
6. Are there any particular times of the work shift the symptoms occur? (As soon as the shift starts, morning only, one hour after shift starts, afternoon only, end of the shift, etc.)
7. Are there any particular areas of the building the symptoms occur? (Floor of the building, area on the floor, department on the floor, etc.)
8. Are there any specific work activities associated with the onset of the symptoms?
9. When do the symptoms go away? (Soon after leaving the work area, the floor, the building, at home, on weekends, etc.)
10. Do you suffer from any of the following? (Asthma, eczema, hayfever or other allergies, migraine, arthritis, painful menstruation, etc.)
11. Are you currently on any medication? (Prescribed, over the counter, etc.)
12. How do you describe your work area? (Air too stuffy; too smoky; too dry; too humid; too drafty, temperature too hot or too cold; lighting too dim or too bright; too much glare; noise level too high, unpleasant chemical odor, etc.)

The primary objective of air sampling is to identify the source of the bio-aerosols so that effective corrective action may be undertaken. Identification, preferably genus and species, of collected microorganisms may be necessary for source determination.

There are three major factors to consider when deciding whether air sampling should be conducted.

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[9] Hall, Stephan, Lavite Sue, "Indoor Air Quality of Commercial Buildings," Pollution Engineering, June 1988.

- **Occupant Complaint(s):**
  The nature of the complaint(s) determined during the walk through is probably the most important factor that influences the sampling approach. Three of the essential characteristics that must be considered are:
  - **Type of illness(es)**
  - **Acuteness of illness(es)**
  - **Prevalence of illness(es)**

- **The Building Itself:**
  - **Size (number of floors and air handling units)**
  - **Number of complaint areas**

- **Capabilities of investigative group:**
  Regardless of the size of the investigation, a group of standard generic types of air samples must be collected. This is to enable an effective comparison to be made for the purpose of determining if microbial amplification has occurred within specific sites of a building.[10]

Air samples should be collected near potential sources and near occupants, both with and without symptoms of hyper- sensitivity lung illness. Outdoor air provides a reference point for determining whether certain organisms are being amplified in the indoor environment. Air samples should be collected at an outdoor site remote from obvious sources of bio-aerosols. In addition, air samples should be obtained near the building's outdoor air intake, and if applicable, in the vicinity of potential bio-aerosol sources such as cooling towers, stored organic material, and dense vegetation. In the indoor environment, samples should be collected in the supply and return air streams of rooms housing affected occupants as well as in other rooms where occupants have no complaints. It is essential to sample at different times during the day and, if at all possible, on different days. Seasonal sampling may be required if you are dealing with a past event. Please refer to Volume II for a recommended bio-aerosol sampling protocol.

Several approaches can be taken to study cases of suspected biological aerosol contamination: 1) All the work can be done by district personnel. To do this, an adequate range of sampling equipment and knowledge of their operation are necessary. Also necessary is a well-equipped microbiology laboratory with personnel experienced in handling environmental microorganisms. 2) District personnel can sample and have a reference lab analyze the samples for you. 3) The district can have a reference lab do both sampling and analysis. Choice of a reference lab should be made depending on specific sampling needs. If sampling and/or analysis of fungi and thermophilic actinomycetes is required, the reference lab should have a mycologist experienced in assessment of environmental fungi. Bacteriologists should be aware of the non-pathogenic nature of usual environmental isolates and the fact that growth conditions are different. Before contracting with a lab, insist that a written protocol be provided. This should include specific details of work to be done and the means of interpretation. The protocol should be in agreement with these guidelines.

The types of samplers useful for viable particle sampling indoors are summarized in Volume II. The samplers that most efficiently collect viable bio-aerosols; i.e., most accurately represent actual concentrations, are the slit to agar samplers and all glass impingers. In general, this degree of accuracy is not essential in most situations and other types of portable samplers may be used. Gravitational deposition plates (Rodac) are generally never recommended for the qualitative or quantitative determination of bio-aerosols.

The types of media used for general detection of bio-aerosols include malt extract agar, Sabouraud dextrose agar, and blood agar. Other media may be used for more specific diagnostic determinations.

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[10] Leeley, James C., "Air Sampling Approaches," University of Michigan Conference; Assessing Bio-aerosol Hazards in the Workplace, September 1987.

Once samples have been collected, they must be submitted to a laboratory for incubation, isolation and identification procedures. Total counts are tabulated for each type of organism in each sample. Normally, analytical results are reported as colony forming units per cubic meter of air sampled (CFU/m^3).

It can be expected that all environmental surfaces contain some microorganisms, therefore, surface swabs and source samples are of little use in documenting bio-aerosol contamination. However, they are desirable as an aid to laboratory analysis of subsequent air samples and to identify potential microbial sources. This would be especially significant if pathogenic organisms are identified on a source.

7. Standards and Guidelines:

Standards have not been adopted by any regulatory agency.

The National Institute for Occupational Safety and Health (NIOSH) has a recommended guideline for bio-aerosols of 1,000 colony-forming units per cubic meter of air. Corrective actions should be implemented if this level is exceeded.

The American Conference of Governmental Industrial Hygienists Committee on Bio-Aerosols has suggested for most situations that indoor bio-aerosol levels should be less than 1/3 of outdoor levels where the outdoor air is the only source of contamination. The genus/species of the organisms should be similar. Also, the committee suggests that if the level of any one organism exceeds 500 CFU/m^3, an indoor source is likely, and corrective actions should be taken.

Absolute numbers of organisms at times offer little value. For pathogens, organisms known to cause human diseases, the presence of even one organism should trigger remedial action.

The outside air sample, preferably collected at the air intakes supplying the building, offers the best standard. If indoor levels are higher, at least double, than outside levels, an interior source can be suspected. If indoor levels are equal or are less than outside levels, a rank order assessment is necessary.

Rank order assessment consists of identifying the sample organisms both inside and outside. The relative abundance of each type (genus) of organism is calculated. If sample locations have the same type of organisms then there should be a similar order of abundance. If a bio-aerosol source is present indoors the types of organisms and/or rank are different than the outside type and rank of organisms.

8. Preventive Measures/Control Methods/Remedial Actions:

Effective remedial action for controlling bio-aerosols most often involves the interruption of the transmission of microorganisms from reservoirs and sources. Two basic requirements for microbial growth are the availability of water and a carbon source. Since any organic material can provide a carbon source,

one very effective remedial action, which involves the disruption of the amplification process, is to remove sources of water in the indoor environment or in the HVAC system that provides air to occupied space. Specific remedial measures that can be taken include the following:

Remove water sources. Remove and prevent the accumulation of stagnant water in HVAC system mechanical components. Maintain relative humidity in indoor spaces at levels less than 70 percent (less than 50 percent where cold surfaces are in contact with room air).

Remove substrates and microbial growth. Remove and discard porous organic materials that are obviously contaminated (e.g., moldy ceiling tiles, mildewed carpets). Wash with dilute bleach (1 cup per gallon of water) all smooth surfaces that have been contaminated by microorganisms. Note that in situations where contaminated materials must be handled, workers should be provided with adequate respiratory protection.

Preventive maintenance. An excellent preventive maintenance program is essential for humidifiers, water spray systems, and other HVAC system components that may become wet. This includes maintenance of slime-free surfaces either by frequent steam cleaning, disinfection or both. HVAC system filters must be replaced at scheduled intervals. Collection efficiency of filters should be maximized depending on HVAC system fan capacity.

Administrative actions. Personnel affected with hypersensitivity diseases should not be returned to the environment until the source of the problem has been identified and corrected. Affected or sensitized personnel may need to be reassigned temporarily to another work environment. If illness persists in the workplace even after remedial actions, affected personnel may need to be permanently reassigned to another area. Persistent illness in sensitized persons, after the problem has been cleaned up, is not necessarily evidence of misdiagnosis of the problem, since environmental cleanup may not be adequate to completely eliminate the biological agent to which a person is sensitized.

Whenever possible, the sampling should be done after remedial actions have been taken to demonstrate effectiveness. Similarly, epidemiologic re-evaluation is important to assure that sensitized persons have been protected from disease progression by remedial actions, including relocation when necessary.[11]

9. Training:

Specific training is not required. Generally, preventive maintenance training for mechanical equipment and effective custodial procedures will be adequate to control bio-aerosol contamination.

10. For Further Information:

- Anne Arundel County Health Department (301) 224-7360
- MOSH Public Sector Consultation (301) 333-4135; or 1-800-492-6226, ext. 4135

11. References:

None

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[11] Morey, Philip, "Recommendations/Remedial Actions," University of Michigan Conference; Assessing Bio-aerosol Hazards in the Workplace, September 1987.

BLOOD AND BODY FLUID SPILLS

1. **Description:**
   Blood and body fluid spills from occupants.

2. **Sources:**
   Personal illness/injury of occupants.

3. **Laws/Regulations:**
   Procedures for cleaning of blood and body fluid spills fall under communicable disease guidelines. The necessary precautions for contacts with blood or body fluid spills are found at the end of this appendix.

4. **Notification:**
   None

5. **Measurement:**
   None

6. **Control Methods:**
   Each school is provided a body fluid spill and first aid kit. The kit should consist of a bucket, disinfectant, barf-clean, disposable gloves, paper towels, sealable plastic bags, band-aids, gauze, and a brush.

Precautions

Please take the following precautions when there is potential for contacts with blood or body fluid spills.

a. Exposure to open skin lesions or mucous membranes to blood or body fluids should be avoided. If open lesions are present, disposable gloves should be worn.
b. Surfaces soiled with blood or body fluids should be immediately and thoroughly cleaned. It is advisable to cover the blood/body fluids with paper towels, flood with appropriate disinfectant and allow it to remain for at least 15 minutes before disposing of paper towels.
c. Disposable materials; e.g., gloves, paper towels, sanitary napkins, should be promptly discarded into sealable plastic bags.
d. Mops and other non-disposable cleaning materials are not recommended, but if used, should be rinsed in the disinfectant.
e. Hands should be washed thoroughly after contact with the blood or body fluids of any child, including after removing disposable gloves (see handwashing procedures on the following page).

7. **Further Information:**
   - Morbidity and Mortality Weekly Reports (MMWR), August 1987.

Handwashing techniques:

Handwashing is the single most important technique for preventing the spread of disease and should be done frequently. It should be done:

1. Before drinking or eating.
2. Before handling clean utensils or equipment.
3. Before and after handling food.
4. Before and after going to the bathroom.

Guidelines for handwashing:

Purpose

To reduce the number of microorganisms on the hands.

Equipment

1. Liquid soap or any soap
2. Towel
3. Hand lotion
4. Covered waste container with disposable plastic liner.

Important Steps

1. Remove all jewelry.
2. Wet hands with running water.
3. Apply soap and lather well.
4. Wash hands, using a circular motion and friction, for 15 to 20 seconds.
5. Rinse hands well under warm, running water.
6. Wipe surfaces surrounding sink.
7. Dry hands well with towel.
8. Apply lotion as desired.

To practice specific health principles designed to protect yourself and others from infection, the following should be done.

1. Maintain optimum health through effective daily health practices, such as adequate nutrition, rest, exercise, and appropriate medical supervision.
2. Avoid rubbing or touching eyes, nose or mouth.
3. Wash hands frequently.
4. Use one's own personal care items, such as combs, fingernail files, nail clippers, lipsticks, and toothbrushes.
5. Keep fingernails clean and trimmed short.

Key Points and Precautions

Include front and back surfaces of hands, between fingers and knuckles, around nails, and the entire wrist area. Avoid harsh scrubbing to prevent skin breaks.

Hold hands under the water so that water drains from wrist area to fingertip.

Because of frequent handwashing, it is important to dry gently ad thoroughly to avoid chapping. Chapped skin breaks open, thus permitting bacteria to enter one's system.

Lotion helps keep skin soft and reduces chapping.

PAINT

1. Description:

Paint provides color and protection for a wide variety of surfaces. Chemists often classify paints according to the way they cure (dry). The two major groups of paint in use today are water-based and solvent-based. Both of these types cure through the evaporation of solvents. All paints have a solid phase known as the pigment, which is responsible for the color, and a liquid phase called the vehicle or binder.

2. Sources:

There are approximately 1,200 companies that manufacture paint in the United States. These companies produce a total of about 990 million gallons of paint annually.

Water-based (latex) paints are not flammable and have little odor. Solvent-based (oil) paints are generally combustible and have a distinctive odor. Latex paint fumes generally have a lower toxicity than solvent-based paints.

3. Health Effects:

There are three primary routes of entry for paint; dermal (skin contact), inhalation (breathing of fumes) and ingestion (eating or swallowing paint). The most common route is inhalation.

Water-based paints, which are generally low in odor, can be used in most areas with minimum risk to an individual's health. However, if an individual is working in a confined or poorly ventilated area, exposure may cause headache and nausea. When these symptoms occur, the individual should immediately remove themselves from the area and seek fresh air.

Solvent-based paint, which has strong odors, can be used safely by following material safety data sheet information, that is provided by paint manufacturers. When solvent-based paints are used in confined or poorly ventilated areas, an individual can experience irritation of the respiratory tract or acute nervous system depression characterized by: headache, dizziness, staggering, confusion or coma. Inhalation by persons with respiratory problems could have the condition additionally aggravated.

4. Methods of Control:

One effective method of control is the use of a painting protocol which gives proper notification to the school administration, parents and students, and minimizes exposure. (The protocol used by AACPS is shown at the end of this appendix.)

Lead Paint

1. Description:

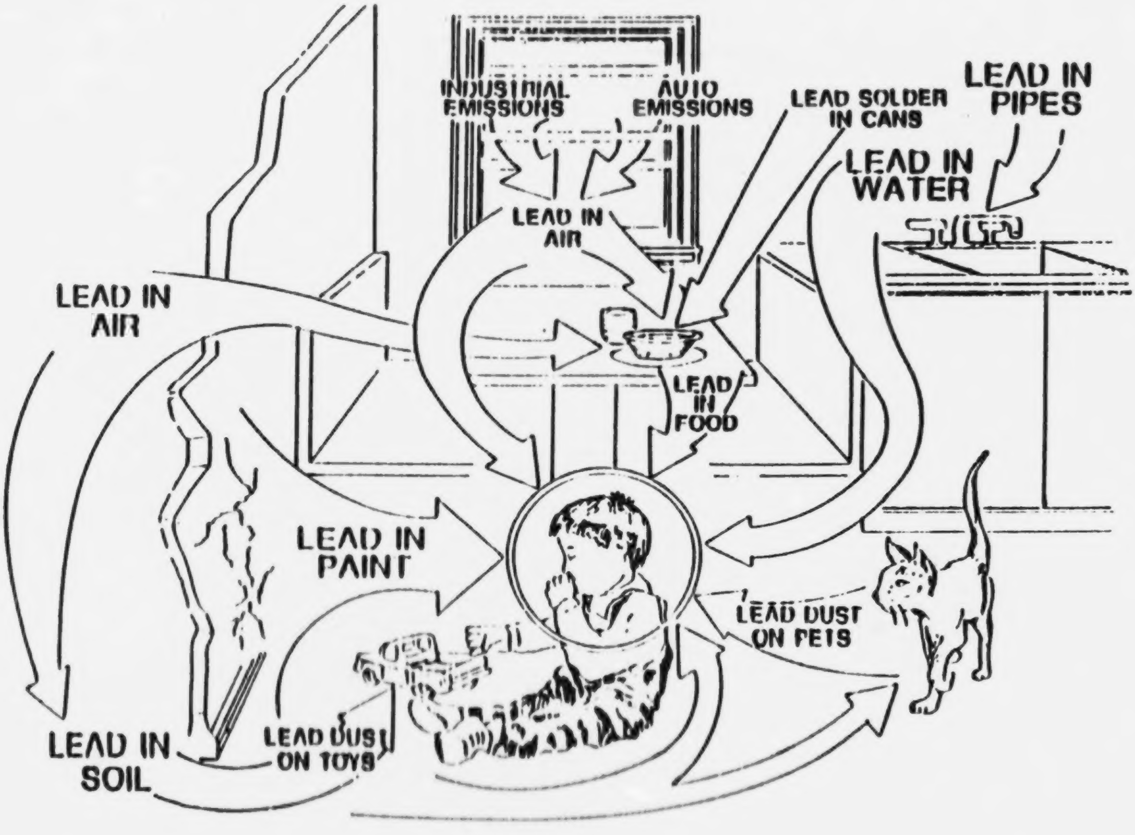
Before 1950, most paints used lead. Lead was used to make several colors, including white, and was used to help paint dry to a hard, durable surface. The use of lead was reduced during the 1960s, but it wasn't until 1977 that Federal Regulations eliminated lead from paints in use for consumers. As lead builds up in the body, it can affect the brain, red blood cells, kidneys, and other parts of the body.

2. Sources:

As a coat of paint gets older, it will crumble, chip and peel. Lead from deteriorating paint gets into dust. Lead dust can end up in a child's mouth. Children may even chew on paint chips or painted surfaces. Children may, also, be exposed to paint dust, chips, and fumes from the rehabilitation of older homes, demolition or structural sand blasting of paint work on bridges, elevated water storage tanks and other steel structures. Workers removing old paint can, if they do not protect themselves, breathe in large amounts of lead from dust and fumes.

Other potential sources of lead poisoning:

Figure I-1.


INDUSTRIAL EMISSIONS
AUTO EMISSIONS
LEAD SOLDER IN CANS
LEAD IN PIPES
LEAD IN WATER
LEAD IN AIR
LEAD IN AIR
LEAD IN FOOD
LEAD IN PAINT
LEAD DUST ON PETS
LEAD IN SOIL
LEAD DUST ON TOYS

3. Health Effects:

Lead poisoning in children is a serious problem. Children may not return to normal after treatment or removal from exposure.

At low levels, lead causes long lasting subtle learning, behavioral and psychological problems. Lead also affects the blood forming organs causing anemia and can damage other body systems such as the kidneys and reproductive organs.

Adults are less susceptible to lead poisoning. They are less likely to have irreversible changes in mental status. Symptoms of lead poisoning in adults include loss of appetite, weight loss, insomnia, headache, irritability and abdominal, muscle and joint pains.

Lead poisoning symptoms tend to be more severe during the summer months. In children, the occurrence and severity of symptoms seems to depend upon the exposure. The earliest symptoms are irritability, loss of appetite and decreased play activity.

4. Laws and Regulations:

Health and Environmental Article of the Annotated Code of Maryland.

6-301 Lead Paint Use (effective date 1957)
This law prohibits the use of lead based paint on interior surfaces, exterior surfaces to which children are exposed and porches of any dwelling.

COMAR (Code of Maryland)
26.02.07 Procedures for Abating Lead Containing Substances from Buildings
This regulation establishes appropriate techniques for abatement of lead paint from interior or exterior areas in residences and group day-care centers.

5. Lead Paint Hazard Determination:

To determine lead paint hazard in a building, painted interior and exterior surfaces should be tested in an environmental survey. The school should be made aware of all lead paint present in the building along with an assessment of hazards.

When a child has been identified as having lead poisoning, the sampling laboratory is required to submit a copy of the lab analysis to the Maryland Department of the Environment. A medical report is required by the Maryland Department of Education. The appropriate health agency will investigate the circumstances. For children who have lead poisoning the sources of lead must be identified and abated. The primary dwelling may not be the source of the hazard, so information regarding prior residence, day care, homes of friends and relatives should be gathered. Secondary sources of lead should also be explored.

6. Measurement:

The two most common types of testing for lead content in paint and by using an X-RF Analyzer (x-ray fluorescence) and by collecting paint scrapings for lead analysis.

The X-RF Analyzer is a field instrument which measures lead content of painted surfaces without removing paint or damaging the surface. The instrument is capable of taking measurements through many layers of paint and giving an immediate on-site reading.

At this time gathering paint scrapings is the most reliable and accurate method for measuring lead content. Wipe sampling can be used to determine the percent of lead in dust on walls and ceilings.

7. Equipment Requirements:

Equipment needed for a lead paint abatement project would depend heavily upon the method used for the abatement. Some common tools and equipment needed include 6 mil. plastic for proper containment, respirators (with HEPA filters), disposable clothing, heat guns (flameless), "Peel Away" (paint removal system), HEPA VAC (special vacuum cleaner for lead dust) and Trisodium Phosphate (TSP) High Phosphate Detergent to clean abated area.

8. Methods of Control:

New Construction - Refer to Health and Environmental Article of the Annotated Code of Maryland. Sec. 6-301.

Renovation - Methods to deal with removal of lead paint vary depending on the status of the facility. Control can range from simple encapsulation to total removal depending on the severity of the condition. While there are no specific guidelines, the ideal situation, ignoring cost, is to totally remove the material containing lead paint in those areas of the school where children below the age of 6 can be potentially exposed. Removal of lead paint beyond this criteria would depend on the condition of the facility and cost considerations. Requirements for abatement methods and safety precautions for workers and equipment are contained in Appendix A, Title 26, Department of the Environment, 26.02.07 Procedure for Abating Lead Containing Substance from Buildings.

9. For Further Information:

- AACPS Maintenance Division (301) 255-2535
- AACPS Office of Health Issues (301) 224-5415

PAINT PROTOCOL
ANNE ARUNDEL COUNTY PUBLIC SCHOOLS
MAINTENANCE DIVISION

This protocol, with attachments, is provided for your use in preparation for the interior painting of your school. Based on past experience, certain steps must be taken by the school prior to the beginning of work to ensure that minimum disruption occurs to the teaching process and maximum information is communicated to the parents.

The Paint Foreman or his designated representative will meet with you no later than one month prior to the start of work to coordinate the effort and cover any items which may be of interest to you. As a minimum, he will need your by room painting priority to schedule his work force in your school. Clearly, classrooms or other confined space must be vacated throughout the painting process. The attached Material Safety Data Sheets will provide information on drying time and other precautions which must be taken. Because of the paint we use, overnight drying is generally all that is required for any area being treated. Thus, if a classroom or other confined space is completed in the afternoon, it will be ready for occupancy the following morning. However, the principal reserves the right not to occupy a classroom until he/she is satisfied occupancy will not pose a hazard to the students. The paint crew generally can complete the average classroom in one day.

Your custodial staff will be required to remove all items from storage rooms no later than 7:30 a.m. the day that room is to be painted. Classrooms will not require the removal of furniture. Common areas such as hallways, gymnasiums and media centers will not require the removal of children or furniture. Rather, close coordination between your staff and the paint crew is needed to ensure that children are kept as far from the area being painted as possible during all painting. The paint crew has been instructed to complete a wall or localized area entirely before moving to another part of that common area facility. Thus, if a wall is being painted in one of these areas, children receiving instruction should be at the other side (end) of the space so to be as far removed as possible. Each paint crew assigned to a particular school, will have the use of floor fans, to help ventilate any or all of the paint fumes generated while painting classrooms and/or related areas.

As it pertains to cafetoriums, painting will not start until after the lunch feeding is completed. This means painting will occur only two to three hours in the afternoon each working day. Clearly, the painting of this facility will take longer than in any other part of the school.

The attached notices to parents are provided for school consideration. All parents must be notified by some means. Two choices are offered, one in the form of an official memorandum; the other, less formal, was designed to be a "flyer."

You may have one or more parents express concern over their child's presence in school during the painting. Since the duration to paint the interior of your school will be a minimum of three months, you and the parent(s) will have to mutually resolve this issue on a case by case basis. The Office of Health Issues, 224-5415, should be contacted for assistance if such concerns do arise.

If you have any questions concerning this memo or the painting process, please contact the Paint Department at 255-2535, or cover your questions or concerns at the scheduled pre-painting meeting.

ANNE ARUNDEL COUNTY PUBLIC SCHOOLS
(NOTICE TO PARENTS)

Name
Address
City, State Zip Code

Dear Parents,

The Maintenance Division plans to start painting in our school on or about ________________.

The health and safety of all students is our primary consideration as the painting crews undertake this maintenance and beautification project. The school plant is an important factor in the functioning of the total educational program. Proper maintenance of school buildings is necessary in providing a healthy and pleasant atmosphere. The majority of paint being used in Anne Arundel County Public Schools is latex water-based. Some heavy traffic areas and trim will require the use of oil-based paint. Paints containing lead are never used in school painting.

Instructional areas will be empty during painting and drying times, and children will not be in the cafeteria while it is being painted.

We anticipate that paint crews will be in the school for a period of ______________, beginning on ______________.

If you have any questions or concerns about the scheduled painting, please feel free to contact me at ______________.

With the cooperation of parents, students, and staff, this painting project will result in a bright, new look for our school. I hope you will stop by when the project is completed to see the results for yourself!

Sincerely,

Principal

DESIGN STANDARDS

Introduction

The intent of this appendix is to provide substantive guidance to the facility owner planning a construction or renovation project. This section is organized into the 16 part Construction Specifiers Institute format to facilitate its use by design professionals. The primary goal is to eliminate to the greatest extent possible the sources of those contaminants which degrade indoor air quality. The secondary goal is control of the level of contamination by limiting or by diluting the contaminant.

DIVISION 1 - GENERAL CONDITIONS

1.1 Specifications

Project designer shall be required to certify that no hazardous material has been specified should substitutions occur, in the project. Provision should be in specs stating general contractor responsible for replacement cost and any resulting damages.

1.2 Testing

An independent laboratory shall be hired by the owner to determine that materials delivered to the project do not contain products expressly forbidden by the specifications. Initial tests will be paid by the owner. If a retest is necessary as a result of substitutions, costs of retest will be the responsibility of the general contractor.

1.3 Submittals

Certification of the composition MSDS information and a list of manufacturer, supplier, etc., will be required of the general contractor for all materials used. This should be a portion of submittals required for final payment.

1.4 Balancing

All air and water systems should be required to be balanced by an independent firm both at time of substantial completion and immediately prior to the end of the warranty period. This should include not only HVAC systems but also local and general exhaust systems.

1.5 Occupancy

Whenever possible occupancy should occur no sooner than two weeks after final installation of finish materials. During that period heating systems should run at capacity, in order to:

a. Test the system
b. Thoroughly dry the material
c. Accelerate any off-gassing.

Fresh air supply during this period should be 100% outdoor air.

1.6 Construction Sequence

General contractor should submit a ventilation plan prior to commencing work. Attention should be given to work on occupied facilities. This plan will demonstrate how the work site and the sources of contaminants will be isolated from occupied areas and avoid contaminants reaching the occupants by infiltration, contamination, or inversion.

1.7 Temporary HVAC

If building HVAC is operated during construction, it should operated with all return air shut off and 100% outside air used. Care must be taken that contaminants from construction activities do not enter the outside air intakes.

DIVISION 2 - SITEWORK

2.0 Selection

In selecting a site, care should be taken to identify potential hazards. Environmentally poor building sites can continually present negative influences on the indoor air quality of a school.

a. As a part of the new school planning, an environmental survey should be conducted to locate any hazardous waste and any underground tanks.
b. The vicinity should be surveyed for any neighboring sources of contamination.
c. The topography and micro climate should be assessed for conditions that may induce short circuiting of exhaust/intake systems.

2.1 Sensitizers

Identify potential sources of organic and inorganic sensitizers and locate fresh air intakes accordingly. The planting of trees and shrubbery in proximity to air intakes should be avoided to eliminate the intake of excessive allergens and to minimize the growth of mold and fungi in shaded, damp areas.

2.2 Layout

Air inlets and exhaust air outlets at the building exterior should be located to avoid contamination of the ventilation air supply. Contaminants from sources such as cooling towers, sanitary vents, vehicular exhaust from parking garages, loading docks, and street traffic should be avoided. Where soils contain high concentrations of radon, ventilation practices that place crawl spaces, basements, or underground ductwork under negative pressure could increase radon concentrations in buildings and should be avoided.

2.3 Outdoor Air

The outdoor air employed for ventilation and dilution of contaminants should not have contaminants exceeding concentration limits stated in the National Ambient Air Quality Standards (NAAQS) as established by the U.S. Environmental Protection Agency and enforced by the Maryland Department of the Environment.

If outdoor air gaseous and particulate contaminant concentrations are known to exceed the maximum levels established by the EPA NAAQS, the air should be treated by filtration and adsorption or other proven gas removal methods to reduce contaminants to acceptable levels.

2.4 Roadways

Schools located near streets and highways may have elevated levels of lead and carbon monoxide in the indoor air. Road surfaces can also produce dirt and dust within a school building. Factors that influence the potential impact of roadways include prevailing meteorological conditions and patterns of road usage.

2.5 Soil

Radon (**Appendix C**) arises from the radioactive decay of certain elements in the soil. Radon levels in the indoor air depend upon the concentration of radon sources in the soil, the potential for migration into the building, and the specific location of concern within the structure. Below grade building levels are more susceptible to radon contamination. Unvented crawl spaces are also potential problems. There is a test to examine soil for radon; however, there is no agreement on how to interpret these tests and apply the findings to school building siting or design. Because of this, pretesting of sites for radon is not recommended.

2.6 Foundation Drainage

DIVISION 3 - CONCRETE

3.0 Slabs on Grade

When a facility is designed as a slab on grade structure, care should be taken to seal all penetrations (plumbing, conduit, etc.) and construction joints. Vinyl gasket material and expansion joint filler should be available for use during concrete pouring. If sealing is necessary after the fact, a quality sealant rated for traffic resistance should be used. A facility with a tightly sealed concrete slab is less subject to concentrations of radon gas.

3.1 Sealers & Curing Agents

Many liquid sealers and curing agents release contaminants during the chemical curing process. Areas to be cured should be well-ventilated. Manufacturer's precautions should be followed. Occupancy should occur no sooner than two weeks following the application.

3.2 Additives

Lightweight concrete additives such as vermiculite or similar materials should be tested for asbestos prior to use.

3.3 Radon

The main pollutant of concern from the presence of concrete, is radon gas. However, truly hazardous radon emanation rates are rare. Studies and surveys of concrete used in various parts of the United States have shown that emanation rates from concrete samples are very small.

DIVISION 4 - MASONRY

4.0 Whenever possible cleaning of existing dirt and residue or construction residue should be done with high pressure water rather than acids.

If acids are used, provisions should be made so that vapors are properly vented and runoff neutralized prior to entry into the storm water or groundwater system.

4.1 Radon

The main pollutant of concern from the presence of brick or rock products is radon gas. However, truly hazardous radon emanation rates are rare.

DIVISION 5 - METALS

5.0 Primers

Primer coating on structural steel must be lead-free. This should be verified by an independent testing lab (DIVISION 1).

5.1 Thermal Expansion

Because structural steel is far more subject to differential movement as a result of temperature changes, care should be taken to isolate steel from masonry with materials that compensate for the movement (i.e. the seal between materials should not be compromised.)

DIVISION 6 - WOOD

6.0 Pressure-Treated Lumber

Pressure-treated lumber (both ground contact and fire resistant) should be sawn in an area that is properly ventilated. Care should be taken not to inhale or ingest the sawdust.

Pressured-treated lumber should not be burned.

6.1 Plywood and Casework

Hardwood plywood or products containing this material must be certified to be in compliance with the Hardwood Plywood Manufacturers Association Voluntary Standard for Low Emissions (HPMA FE-86) and the U.S. Department of Housing & Urban Development Standard 24 CFR part 3280.

6.2 Particle Board and Casework

Particle board or products containing this material must be certified to be in compliance with the National Particle Board Association Voluntary Standard for Formaldehyde Emissions (NPA-987) and in compliance with U.S. Department of Housing and Urban Development Standard (24 CFR Part 3280).

All pre-drilled holes in plastic laminate casework must be plugged prior to delivery to the job site. ALL edges of particle board are to be covered with plastic laminate.

DIVISION 7 - THERMAL AND MOISTURE PROTECTION

7.0 Roofing Felts

All roofing felts should be certified asbestos-free.

7.1 Roofing Cement

All roofing cement should be certified asbestos-free.

7.2 Coal Tar Pitch

All coal tar pitch used should be certified asbestos-free.

7.3 Vermiculite

All vermiculite should be certified as asbestos-free.

7.4 Polyisocyanurates and Some Polystyrenes

Polyisocyanurates and some polystyrenes have been found to off-gas hazardous chemicals when burned. Follow all manufacturer's recommendations regarding proper installation of these insulting materials.

7.5 Sealants

These compounds are used in a variety of applications. Caulks are used around windows and doors to lower infiltration rates through building envelopes. Caulks are also used in bathrooms around showers, water fixtures, and tile to prevent water leakage. Sealants are commonly used to waterproof surfaces and roof joints. Adhesives are used to install asphalt tile, to secure wall and floor panels, and to fulfill a variety of miscellaneous needs.

VOC emissions from sealants, adhesives, and caulks are difficult to characterize. A large number of different compounds have been found to be emitted from these materials. The composition and intensity of the emissions vary depending on the compound. In large part, these emissions depend on the type of solvent used in the specific formulation for each compound. Also, emission rates tend to be highest during the curing period. Studies to date indicate that it would be prudent to reduce the use of these materials to the extent possible and provide adequate ventilation when in use and while curing.

7.6 Vapor Barrier

For slab on grade concrete a vapor barrier of 6 mil polyethylene should be placed prior to concrete placement.

DIVISION 8 - DOORS AND WINDOWS

8.0 Natural Ventilation

Natural ventilation is defined as the movement of air into and out of a space through intentionally provided openings such as windows and doors, through non-powered ventilators, or by infiltration. Natural ventilation in Maryland schools is normally a supplementary rather than the primary means of ventilation. The ability to provide ventilation through operable windows is desirable for emergency use; for example, as heat relief in the absence of air conditioning or for purging smoke from a fire. If employed, natural ventilation should not prevent reasonable control of the thermal environment or otherwise impair the intended use of the space.

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DIVISION 9 - FINISHES

9.0 Floor Coverings, Carpet, Vinyl Products

Adhesives used to apply flooring often contains VOCs capable of causing health problems. One contaminant emanating from carpet is formaldehyde used as glues in carpet backings. Vinyl products can off-gas plasticizers. Both of these emissions diminish dramatically over time. Wool fibers can cause allergic reactions in sensitized individuals. Vinyl asbestos tile remains in many school and office buildings. Acceptable work and disposal practices must be used when repairing removing, or otherwise disturbing this material.

A two week off-gassing period should be instituted between installation and occupancy.

9.1 Asbestos

The following materials should be certified asbestos free by independent tests:

A. Vinyl composition tile
B. Plaster
C. Gypsum Board joint compound
D. Stage curtains
E. Ceiling tile
F. Fritz tile
G. Perlite (spray texture)

9.2 Paints and Epoxy Coatings

Paints and epoxy coatings are highly variable mixtures of VOCs and it is difficult to predict emission rates. VOC release is short-term during the curing process with much lower levels over time. Paint should be applied and cured only in well ventilated conditions. Follow manufacturer's precautions.

9.3 Urea-Formaldehyde Foam Insulation (UFFI)

In the past UFFI was used as an insulation material because of its many desirable properties. The precise formulations used in these applications were usually proprietary, but essentially, UFFI consisted of the same glue used in various pressed wood products, a strong acid used to cure the glue, and a foaming chemical called a surfactant. These agents were mixed at the injection point and immediately introduced into the wall to be insulated.

Environmental factors and improper formulation can lead to significant emissions of formaldehyde from this type of foam insulation. High humidity increases the decomposition rate of the polymer, leading to formaldehyde release. Excess resin in the mixture will also evaporate over a period of time, since it is not chemically bound. In addition, temperatures above that of a normal room will significantly aggravate both of these conditions. UFFI has now been banned in Canada and parts of the United States. UFFI will not be specified in any AACPS buildings.

9.4 Ceiling Tiles

All acoustical ceiling tiles should be certified asbestos free.

Some tiles have been identified as sources of VOCs and formaldehyde (binders). It is recommended VOCs (surface-coating) that these materials be installed prior to the pre-occupancy ventilation period.

9.5 Gypsum Board

Gypsum is a major component of wall-board (sheet rock). Although it has been theorized that gypsum made with phosphorus-containing material would produce significant amounts of radon, surveys have indicated that no significant increase in indoor levels of radon have been attributed to this source.

DIVISION 11 - EQUIPMENT

11. Ventilation

Special care should be taken to insure proper exhaust systems for dark rooms, kiln rooms, duplicating equipment, spray booths, woodworking dust-collection, and kitchen equipment. Proper operation of this equipment should be included in pre-occupancy balancing reports and also in the post-occupancy inspection during the guarantee period.

DIVISION 15 - MECHANICAL

THERMAL ENVIRONMENT

15.0 Air Temperature

The air temperature in a space that is likely to produce acceptable comfort to a majority of occupants is dependent upon several interacting variables. They include individual physiology, clothing, activity, and preference. For classrooms and offices where students, faculty, and staff are mainly sedentary, 68 to 75 degrees Fahrenheit represents a range of acceptability during winter. During summer, the range of acceptability will be higher. The effects of other variables upon the acceptable level of air temperature are discussed below.

15.1 Radiant Heat Effect on Temperature

The body transfers heat to and from surrounding surfaces, such as walls or windows, by radiation. The rate of exchange is dependent upon the temperature difference between the body, the space geometry, building construction, and the location of the individual. A space enclosed even partially by cold walls will require a higher air temperature for comfort than one with surfaces at space temperature, especially for those seated near the cold surfaces. For example, students seated near a large window without a source of heat to warm the glass surface will notice radiant heat loss to that surface during cold weather. They will generally prefer a warmer room or more clothing than others in the room farther away from the outside wall. Radiation to or from cold or hot surfaces to the body may be asymmetrical (e.g., radiation on the back, but not the front) such that discomfort will result regardless of adjustments in air temperature. Discomfort can occur where a person is seated in direct sunlight or close to a large, unheated or unshaded single-pane glass window.

15.2 Uniformity

Air temperature within a room generally increases from floor to ceiling. If a sufficiently large difference exists in the occupied zone so that the temperature at the head is more than 5 degrees Fahrenheit higher than near the floor, discomfort may result. Good air mixing, and insulation of wall and floor surfaces can reduce temperature differences.

15.3 Floor Temperature

To minimize foot discomfort, the surface temperature of the floor should be between 65 and 84 degrees Fahrenheit. Floors of occupied spaces above unheated areas require adequate insulation. Similarly, floors above boiler rooms may require insulation for foot comfort and to control heat gain to the space above.

15.4 Temperature Change

Some space temperature controls can produce sufficiently large changes or rapid rates of change in the operative temperature (as defined by ASHRAE) of a space that will cause discomfort. Control strategies that may cause this phenomenon are two position (on-off); wide dead band (a large space temperature span between modes of air conditioning when the control provides neither heating nor cooling); and wide proportioning band (requiring a large air temperature change at the control to vary the heating or cooling from minimum to maximum capacity). For example, a prolonged off-cycle for a control of a heater on an outside wall could result in down drafts at the wall and a large change in temperature, especially in the lower level of the occupied zone close to the wall.

15.5 Humidity

In educational facilities the thermal effect of humidity on the comfort of sedentary individuals is small. If the humidity level is too high or low, concerns may arise over mold or bacteria growth and respiratory health effects. The optimum range for relative humidity in summer is 40-60% and 30-50% in winter. It is necessary to limit humidity levels to 30% in winter to prevent condensation on windows, metal sash and uninsulated walls.

15.6 Air Movement

Sufficient air movement will be provided to achieve thermal comfort, and the dilution of contaminants within occupied spaces. This will require adequate amounts of ventilation air meeting ASHRAE Standards. Supply and return air distribution systems serving occupied zones should be designed and operated to achieve effective ventilation and temperature uniformity during all operating modes during the occupancy period. In winter, average air movement above 30 feet per minute in the occupied zone may result in uncomfortable drafts.

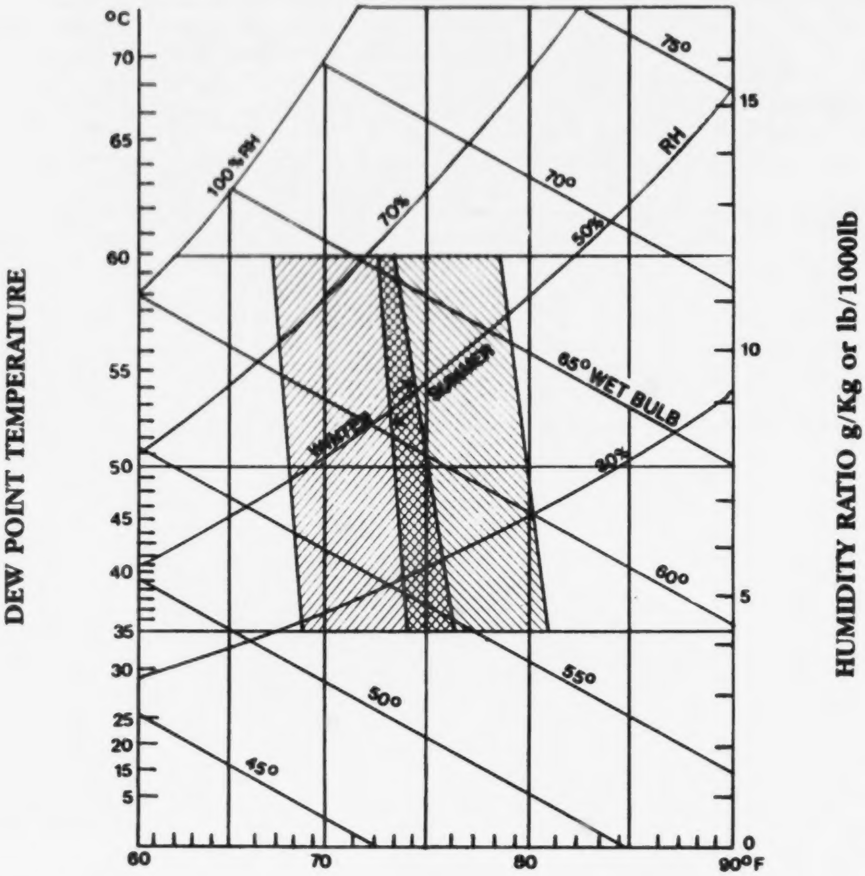
15.7 Clothing

The insulation value of clothing varies depending upon the season and the outdoor climate; indoor clothing worn in winter can be twice that worn in summer. Thus the comfort range of operative temperatures is higher in summer than in winter. Since this shifting of the comfort temperature range is usually consistent with energy conservation, it also is a sound basis for operation and, where necessary, seasonal adjustments of space thermostat settings. Additionally, appropriate attire to the season should be encouraged to promote comfort and effective energy use.

15.8 Activity Level

The range of comfortable operative temperatures shifts downward as the average physical activity level and metabolic rate become higher than the level for lightly clothed, mainly sedentary activity upon which Figure J-1 is based. For equal clothing insulation, industrial arts shops with higher levels of activity than the average classroom could have comfort ranges 3 degrees Fahrenheit below the typical classroom. However, this shift in the comfort range could be materially offset by the shedding of some clothing - a common occurrence with the onset of greater physical activity.

Figure J-1. Operative Temperature



Acceptable ranges of operative temperature and humidity for persons clothed in typical summer and winter clothing, at light, mainly sedentary, activity.

15.9 HVAC Systems

Building spaces with dissimilar heating and cooling load characteristics, such as amount of window exposure, occupancy patterns, and internal energy sources should have independent means of temperature control. Interior spaces generally should not be on the same temperature control zone as spaces on the perimeter of the building. In winter, interior spaces frequently may require cooling while perimeter spaces may require cooling or heating.

Interior spaces, such as offices, may be grouped on a common zone when the thermal load characteristics and occupancy profiles are quite similar. Classrooms, libraries, and gymnasiums should be zoned separately.

When a satisfactory thermal environment must be provided for certain sections of a school building at times when most of the building is unoccupied and unused, separate systems with independent control of heating and cooling will be necessary. For example, it would be uneconomical to air condition an entire school building in summer months when only the office staff may be at work and require comfort conditions.

Provide access to cooling coils, ductwork air cleaning devices, humidifiers, and condensate pans for inspection and maintenance work.

When designing the HVAC System do not assume that recirculated air can be used to reduce the amount of outdoor air introduced. The alternative is high efficiency filtering. Avoid or minimize the use of internal duct liners.

Do not place internal liners in proximity to and down stream from cooling coils and humidifiers. In general, internal insulation of ductwork should be discouraged.

Avoid having ductwork contact high conductivity materials which are exposed to the outdoors.

Access panels to the interior of ductwork must be provided a key locations for inspections and cleaning; e.g., humidifier, turning vanes, etc.

All roof-top HVAC equipment should be located a minimum of 8 inches above the finished roof.

The heating, ventilating and air conditioning system must be designed using ASHRAE Standard 62-1981R in public review draft or final published form. Figure J-2 should be followed assuming a CO_2 concentration of 1000 ppm or less.

Figure J-2. Outdoor Air Requirements for Ventilation*

Applications	Estimated Max. Occupancy People/1,000 Ft.^{2}	Outdoor Air		Notes
		CFM/ Person	CFM/ Ft.^{2}	
Classrooms	50	15	-	
Laboratories	30	20	-	Note 1
Training Shops	30	20	-	Note 1
Music Rooms	50	15	-	
Libraries	20	15	-	
Corridors	-	-	0.1	
Auditoriums	150	15	-	
Smoking Lounges	70	60	-	
Office Space	7	20	-	
Conference Rooms	50	20	-	Note 2
Reception Areas	60	15	-	
Locker Rooms	-	-	0.5	
Gymnasiums (Playing Floors)	30	20	-	
Swimming Pools	30	20	-	Note 3
Spectator Areas	150	15	-	
Public Restrooms	-	50	-	Note 4
Darkrooms	-	-	0.5	
Kitchens	20	15		Note 5
Cafeteria	100	15		

Note 1 Special contaminant control systems may be required for processes or functions.
Note 2 Supplementary tobacco smoke removal equipment may be required.
Note 3 Higher values may be required for humidity control.
Note 4 Value given is cfm per water closet or urinal.
Note 5 Make-up air for hood exhaust may require more ventilation air. The sum of outdoor air and transfer air of acceptable quality from adjacent spaces should provide an exhaust rate of not less than 1.5 cfm per ft.^{2}.

* Table 2 and other material contained in these guidelines have been extracted from proposed ANSI/ASHRAE Standard 62-1981R published in draft form for public review dated July 15, 1986. It must be recognized that certain data and material ultimately published in the completed standard may differ from that contained in the draft.

Direct exhaust to the outdoors is required for several activities:

- **Science Demonstration**
- **Kiln Firming**
- **Welding**
- **Tobacco Smoking in Teachers Lounge**
- **Internal Combustion Engine Use**
- **Spray - Painting**
- **Cutting and Milling**
- **Cooking**
- **Rest Room Exhaust**
- **Dryers**

HVAC to various areas (e.g., Art, Science & Home Economics rooms) should be designed to avoid cross contamination to other areas.

When humidifier systems are required, steam as the moisture source is preferred to recirculated water. A dedicated steam system should be used. Steam from a central boiler system should never be used.

Filters should be placed upstream from the air conditioning unit to protect equipment and occupants.

15.9.1 Filters

A combination of high efficiency media filtering and dilution should be used to control air contaminants. The long term cost and unreliability of sophisticated filters (electronic, electrostatic, HEPA) preclude their use. The total reliance on dilution (and low efficiency media filters) is not energy efficient. Filter access placement should consider ease of replacement.

The HVAC system should be designed such that the relative humidity never exceeds 70% especially in ductwork. Relative humidity in schools should not be below 30% in winter or 40% in summer.

Fresh air intakes should be a minimum of six inches above grade and a minimum of 25 feet from pollutant source such as a cooling tower, contaminated exhaust, or parent drop-off/pick-up area.

15.9.2 Condensate pans

Design of condensate pans should take into account:
    Slope of pan
    Drain location (bottom vs. side)
    Drain into drain (w/trap)
    Easy maintenance

ROOFING

Introduction

Roofs are being addressed since tasks associated with the repair, replacement and new construction of flat roofs have the potential for affecting the air quality in the school plant. (See discussion in text, page 61.) While there is limited documentation addressing the potential hazards, the AACPS has experienced sufficient problems in the past to warrant including roofing as an indoor air quality concern. This section will address the use of built up or membrane type roofing.

1. Description:

Flat roofs are generally constructed using two methods for moisture protection. One is the use of built up materials (more commonly found in older construction) and the other is the use of synthetic membranes (used in new construction and roof replacement projects). The repair/replacement of a built up roof can influence indoor air quality if the moist materials are not totally replaced. If the failed materials remain, it is possible that moisture can be trapped and potentially create adverse conditions in the interior of the school. Moisture can result in unpleasant odors and is a source for the growth of bacteria and organisms. Replacing either a built up or membrane roof with a membrane can cause air quality problems if proper measures are not taken to insure that old moisture laden materials are fully removed. The process of installing a membrane can cause indoor air problems and precautions must be taken during the application of the bonding agents. These agents can get into roof vents or other openings and create air quality problems.

2. Sources:

Sources of air quality problems are derived from moist roof materials. These problems persist if the moist materials are not removed as part of a repair or replacement project. Moisture is captured and over time can infiltrate into the school. The potential hazard with the installation of new membrane is the bond or adhesive material used to seal seems and cracks.

3. Health Effects:

Roof materials themselves do not pose health effects. However, the latent effects of not removing moist materials can cause bacteria growth. Furthermore, if the adhesive agents used during the installation process are not properly vented, the fumes could be drawn to vents and enter the interior of the school. A concentration of these fumes can cause headaches, nausea, eyes and skin irritation and dryness in the mouth.

4. Laws and Regulations:

As prescribed in the appropriate Material Safety Data Sheets for each of the substances used in the installation of a new/replaced roof.

5. Notification:

AACPS Maintenance Division
AACPS Planning/Construction Division

6. Measurement:

Generally not applicable. However, use of infrared can locate hot (wet) spots within the roof system.

7. Standards and Guidelines:

As specified in each project/contract associated with the repair/replacement/construction of a flat roof.

8. Control Methods:

The appropriate agency responsible for developing plans and specifications to replace/repair/construct flat roofs must ensure that the specifications clearly spell out the requirement for the contractor to remove all failed materials, especially remove all moist material. Specifications must also prescribe that the contractor take the appropriate precautions with the development of a ventilation plan to insure that fumes associated with installing built up materials or membranes cannot infiltrate in to the school during the installation. Every effort should be made to perform work in the summer months and/or during school vacation periods. During the drilling of the roof, effort should be made to minimize the amount of dust generated and ensure ventilation to the school is not compromised.

9. For Further Information:

- AACPS Maintenance Division (301) 255-2535
- AACPS Construction Division (301) 224-5151
- Manufacturers of roofing systems have "customer relations" offices which can be contacted for specific questions.

ACRONYMS, ABBREVIATIONS

Acetone
By-products of human metabolism, cleaners, personal care products, tobacco smoke.

ACH
Air changes per hour

ACM
Asbestos containing material

Acrolein
Aldehyde found in tobacco smoke.

AHERA
Asbestos Hazard Emergency Response Act

AIHA
American Industrial Hygiene Association

Alcohols
By-products of human metabolism, cleaners, personal care products, tobacco smoke.

Allergens and Pathogens
Biological material, bacteria, viruses, fungi, mold spores, pollens, and insect parts are ubiquitous in indoor environments. These particulates range from less than one to several microns in size. When airborne, they are usually attached to dust particles of various sizes so that all sizes of airborne particulates may include them.

Ammonia
Cleaners, tobacco smoke.

ANSI
American National Standards Institute

Aromatic hydrocarbons
Compounds found in combustion processes, paints, solvents, tobacco smoke.

Asbestos
Composed of small natural mineral silicate fibers. Included in the definition are chrysotile, crocidolite, amosite, and the fibrous varieties of anthophyllite, tremolite and actinolite

ASHRAE
American Society of Heating, Refrigerating and Air Conditioning Engineers

Basal
At rest.

Benzene
Aromatic compound found in combustion processes, gasoline, solvents, tobacco smoke.

Biomatter
Organic matter such as dandruff, hair, parts of insects, skin.

BOCA
Building Officials and Code Administrators

Carbon monoxide
CO is a colorless, odorless, and tasteless gas. It results from incomplete oxidation of carbon in combustion.

Carbon dioxide
CO_2 is an odorless, tasteless and colorless product of completed carbon combustion.

CERCLA
Comprehensive Environmental Response, Compensation, and Liability Act or "Superfund"

Chlorinated hydrocarbons
PCBs, wood preservatives, solvents.

cfm
Cubic feet per minute

CIAQ
Committee on Indoor Air Quality - An interagency committee of the federal government.

CO
Carbon monoxide

CO_2
Carbon dioxide

COMAR
Code of Maryland

CPSC
Consumer Product Safety Commission

DHHS
Department of Health and Human Services

DOE
Department of Energy

EPA
Environmental Protection Agency

FIFRA
Federal Insecticide, Fungicide, and Rodenticide Act

f/cm^3
Fibers per cubic centimeter

fpm
Feet per minute

Formaldehyde
Colorless water-soluble gas. Due to its wide use, it is frequently considered separately from other volatile organic compounds (VOC's).

FTC
Federal Trade Commission

GSA
General Services Administration

HCHO
Formaldehyde

HEPA
High efficiency particulate air

HUD
Department of Housing and Urban Development

HVAC
Heating, Ventilation, and Air-Conditioning

mg/m^3
Milligrams per cubic meter

NAAQS
National Ambient Air Quality Standards

NAS
National Academy of Sciences

NESHAPs
National Emissions Standards for Hazardous Air Pollutants

NFPA
National Fire Protection Code Administrators

NIOSH
National Institute for Occupational Safety and Health

Nitrogen oxides
The two most prevalent oxides of nitrogen are nitrogen dioxide (NO_2) and nitric oxide (NO). Both are toxic gases with NO_2 being a highly reactive oxidant, and corrosive. NO gradually reacts with the oxygen in the air to form NO_2.

NO
Nitrogen oxide

NO_2
Nitrogen dioxide

Organophosphates
A group of pesticides

OSHA
Occupational Safety and Health Administration

Other Volatile Organic Compounds (VOCs)
There are hundreds of other volatile organic compounds that are found in the indoor air, sometimes in concentrations which are suspected of being harmful. Those listed do not comprise a complete list. Acetone, acrolein, alcohols, ammonia, aromatic hydrocarbons, benzene, chlorinated hydrocarbons, organophosphates, phenols, toluene.

PCBs
Polychlorinated biphenyls

PELs
Permissible exposure limits

Phenols
Equipment, furnishings, tobacco smoke.

Picocuries (pico = one trillionth)
A unit quantity of any radioactive nuclide in which 3.7×10^{10} disintegrations occur per second.

ppm
Parts per million

Radon
A radioactive gas, the first decay product of radium-226. It decays into solid alpha emitters which can be both inhaled directly or attach to dust particles which are inhaled. The unit of measure for radon is picocuries per liter (pCi/1).

Respirable (usually size) **Particulates**
Ten microns of less in size.

RH
Relative humidity

RSP
Respirable suspended particles

SDWA
Safe Drinking Water Act

SMACNA
Sheet Metal and Air Conditioning Contractors National Association

TEM
Transmission electron microscopy

TLVs
Threshold limit values

Tobacco smoke
Consists of solid particles, liquid droplets, vapors and gases resulting from tobacco combustion products are almost in the respirable range, and over 4,000 specific materials have been identified in the particulates and associated gases.

Toluene
An aromatic hydrocarbon found in adhesives, gasoline, paints, solvents, tobacco smoke.

TSCA
Toxic Substances Control Act

TSP
Total suspended particulate concentration

UFFI
Urea-Formaldehyde foam insulation

ug/m^3
Micrograms per cubic meter

um
Micrometer

VAV
Variable air volume

VOC
Volatile organic compound

WEEL
Workplace environmental exposure limit

DRAFT

INDOOR AIR QUALITY MANAGEMENT PROGRAM

VOLUME II

INFORMATION SUPPLEMENT

Anne Arundel County Public Schools
Annapolis, Maryland 21401

APPENDICES SUPPLEMENT

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"Asbestos Appendix Supplement"

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A. Asbestos Removal Protocol (Anne Arundel County Schools)[1]
B. Definitions Relative to Asbestos Abatement
C. Asbestos Work Practices
D. Asbestos
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  2. What is Asbestos?
  3. Occurrence of Asbestos
  4. Production and use of Asbestos Fibers and Products
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  6. Medical Implications of Asbestos
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E. Control of the Asbestos Hazard "Physical Control"
F. Asbestos Abatement Options[2]
G. Table - Asbestos Substitute Materials[3]
H. Asbestos Glossary
I. Federal Register (E.P.A.), 40 CFR Part 763 - Asbestos - Containing Materials in Schools; Final Rule and Notice[4]
J. Suspend the Rules and Pass the Bill, H.R. 3893,[5]
K. Federal Register - Department of Labor, Occupational Safety and Health Administration 29CFR Part 1926 Construction Occupational Exposure to Asbestos, Tremolite, Anthophyllite, and Actinolite; Final Rules[6]
L. Asbestos Abatement Information Sheet Anne Arundel County Public Schools.
M. Asbestos Abatement Notification Anne Arundel County Public Schools

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[1] U.S. Department of Health and Human Services, "Asbestos," Public Health Service, National Institute of Health, 1981.

[2] Maryland Asbestos Safety and Health Program, "Asbestos Abatement Options" Policy and Procedures Manual, Center for Environmental Health.

[3] Maryland Department of Health and Mental Hygiene, "Asbestos Substitute Materials," Division of Environmental Disease Control, Baltimore, MD.

[4] Environmental Protection Agency, "Asbestos Containing Materials In Schools," 40 CFR, Part 763, Final Rule, Washington D.C., Oct 1987.

[5] Environmental Protection Agency, :Suspend the Rule and Pass the Bill," U.S. Congress H.R. 3893, As Reported with Amendment, Washington D.C., June, 1988.

[6] Department of Labor, "Occupational Exposure to Asbestos, Tremolite, Anthophyllite, and Actinolite, Final Rules," Occupational Safety and Health Administration 29 CFR, Park 1926, Construction., Washington D.C., June 1986.

Section II
"Tobacco Smoke Appendix Supplement"

Contents:

A. Chemistry and Biochemistry of Tobacco Smoke[1]

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[1] National Institute on Drug Abuse, "Research 26 Monograph Service," Division of Research, Rockville, Md., August 1979.

Section III
"Radon Appendix Supplement"

Contents:

A. Reducing Indoor Radon[1]

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[1] New York State Energy Office. Reducing Indoor Radon: Training Manual. Albany: 1987.

Section IV
"Formaldehyde Appendix Supplement"

Contents:

A. Federal Register, Part II, Department of Labor., Occupation Safety and Health Administration., 29 CFR Parts 1910 and 1926 Occupational Exposure to Formaldehyde Final Rule[1]

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[1] Department of Labor, "Occupational exposure to Formaldehyde," Final Rule 29 CFR Parts 1910 and 1926, O.S.H.S., Washington D.C., 1987.

Section V
"Bio-Aerosols Appendix Supplement"

Contents:

A. Methods for Control of Toxic Chemicals, Physical, or Biological Hazards in Human Environments.

B. Indoor Air Quality of Commercial Buildings[1]

C. Samplers recommend for viable microbiological aerosols

D. Indoor Air Quality Survey (Building Occupant Questionnaire).

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[1] Hall, Stevens, and Lavite, Susan. "Indoor Air Quality of Commercial builds"., Pollution Engineering, Department of Occupational Health, School of Allied Health, Medical College of Ohio, Toledo Ohio.

Section VI
"Body Fluids Appendix Supplement"

Contents:

A. MOSHA Draft - Occupational Exposure to Blood-born Infectious Diseases[1]

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[1] Maryland Occupational Safety and Health, "Occupational Exposure to Blood-Bourne Infectious Diseases," Department of Licensing and Regulation, division of Labor and Industry Baltimore, MD.

Section VII
"Design Standards Appendix Supplement"

Contents:

A. Comparison Measured Air Leakage Rates and Indoor Air Pollutant Concentrations with Design Standards for Energy Efficient Residential Buildings[1]

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[1] Harris, Jeff, "Comparison of Measured Air Leakage Rates and Indoor Air Pollutant Concentrations with Design Standards for Energy Efficient Residential Buildings," Division of Residential Programs, Bonneville Power Administration, Portland, OR.

Section VIII
"HVAC Specifics Appendix Supplement"

Contents:

A. Ventilation, Health and Energy Conservation - A Workable Compromise[1]

B. Levels and Controls of Environmental Tobacco Smoke in Mechanically - Ventilated Office Buildings[2]

C. Design and Application of Air Filtration Systems for Supplying Ventilation to Commercial Buildings[3]

D. Optimizing Energy Efficiency and Indoor Air Quality[4]

E. Assessing Options for Controlling Indoor Air Quality in New Energy - Efficient Homes[5]

F. Ventilation and Indoor Air Quality[6]

G. Comparison of Indoor Air Quality in conventional and model conservation standard new homes in the Northwest[7]

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